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Designing with-in nature

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SYMBIOTIC DESIGN PRACTICE:

Designing with-in nature

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Contents

List of Figures..vi

Acknowledgments..viii

Declaration..x

Autobiographical Statement..xi

Abstract..xviii

Preface...... xix

Chapter 1. Designing for a living planet (the meta-context of design): Introduction

1.1 An ecological turning point in design..1

1.1.1 On learning how to become humans by thinking ecologically 3

1.1.2 The Way of the Ecological Designer..6

1.2 On design education for the 21st century: From knowledge to wisdom..14

1.2.1 The Importance of Ecological Literacy and Ecopedagogy in Design 22

1.2.2 Deep ecology and its value for a new design education 29

1.2.3 Learning Design in an Age of Enlivenment..31

1.3 Building the foundations for a new design ecopedagogy..35

1.3.1 The new profile of the ecological designer: A participant of a living planet..38

1.4 Relevance of this research for Design Education 42

1.4.1 Research Aims and Objectives..43

1.4.2 Research Questions..44

1.4.3 Research Objectives..44

Chapter 2. Framing a symbiotic design inquiry: Research rationale and methodology

2.1 A symbiotic design inquiry 46

2.1.1 Research Approach 47

2.1.2 Research Rationale..52

2.2 Integrating the eco-techniques: Framework development 55

2.3 Implementing eco-techniques: Research methodology process 61

2.3.1 Methods Description 64

2.3.2 Limitations and Ethics 65

2.3.3 Pilot Workshop 1 (undergraduate level) 66

2.3.4 Pilot Workshop (postgraduate level) 71

2.3.5 Formal Workshops 1 (Undergraduate level) 73

2.3.6 Improvement Workshops (postgraduates) 74

2.3.7 Final Formal Workshop (undergraduates) 75

2.4 Facilitating a symbiotic design practice: A meta-pedagogical outcome 76

Chapter 3. The Biophilic Being: Reconnecting creative minds with nature 78

3.1 Awakening biophilic minds: *Awareness stage (Divergent)* 78

i. Introduction to Biophilia 79

ii. Encountering the natural self: Deep ecological awareness of design 83

3.1.1 Empathy with nature: An unconscious affiliation 89

3.1.1.1 Stimulative Biophilic Practices 89

a. The use of the Natural Classroom 89

b. Sensing the place: Activating our senses 92

c. Mindfulness and Biophilia: Awakening the unconcious self 101

d. Ecosomatics and design: Stimulationg our creative body 105

3.2 Finding meaning in Nature: *Understanding Stage (Convergent)* 116

i. Rewilding our minds 116

ii. Biophilic beings, biophilic designers, biophilic world 118

3.2.1 Engaging with nature: A conscious affiliation 119

3.2.1.1 Engaging biophilic practices 114

a. The Goethean Method as a way to achieve biophilia 116

b. Shapeshifting: Defining non-human centred design 123

c. Enhancing our Naturalistic lenses 127

3.3 Reconnecting with nature: Reconnect Phase 135

3.3.1 Biophilic shift: Becoming animals, becoming humans, becoming designers....................135

3.3.2 Reconnect with Nature before briefing a design need 137

3.3.3 Foundations: The character of the biophilic being 138

Chapter 4. The Biomimetic Practitioner: Rediscovering the wisdom of nature to become designers 142

4.1 Learning from Nature: Understanding Stage (Divergent) 142

i. The bio-mimetic momentum..143

ii. Nature as Design Teacher...147

iii. The value to learn with nature and the biophilic connection 150

iv. Nature-Artifice: Between superficial and deeper meaning..152

4.1.1 Ideate with Nature: Between inspiration and meaningful aesthetics 154

4.1.1.1 Inspiring biomimetic practices...155

a. Lessons from the past: A Bio-inspired history.. 160

b. Why biomimicry now? A renaissance of a bio-technic... 166

c. Contemporary examples of biomimetic design 172

d. Beyond metaphor and analogy: The social meaning of Biomimicry.................................176

e. Mimicking natural Forms, Functions, Processes and Systems: Briefing the design challenge 182

4.2 Designing as Nature: Action Stage (Convergent) 186

i. Co-evolutionary aspects of biomimetic design 186

ii. Memes and Biomimicry 190

iii. Biomimicry as an interdisciplinary creative process 192

iv. How biology works, how design interprets..195

4.2.1 Prototyping with Nature: Biomimicry as conscious design intention 197

4.2.1.1 Biomimetic practitioner's tools...192

a. The methods of biomimicry 197

b. Natural Prototyping: The value of designing as nature 202

4.3 Guided by Nature: Rediscover Phase 204

4.3.1 The ethical values of biomimicry 204

4.3.2 Foundations: The character of the Biomimetic practitioner 206

Chapter 5. The Resilient Thinker: Changing worldviews to design along with natural systems 210

5.1 Change by design: Action Stage (Divergent) 210

i. Resilient scenarios: Finding a natural rhythm..211

ii. From sustainable to resilient? 215

5.1.1 Forecasting change with Nature: Resilience, Global Challenges and Design 217

5.1.1.1 Resilient thinking tools..217

a. Visualizing Resilience is Visualizing Systems...222

b. Framing wicked problems through systems thinking..227

c. Resilient Rhythm: The need to Change along with Nature 232

d. Protopias, Utopias, Dystopias: Future Now by Design... 240

5.2 Evaluating with Nature: Legacy Stage (Convergent) 247

i. Life-Meaning design: Natural design ethics to achieve resilience 247

ii. Inheritance: Rethinking our role as designers 251

5.2.1 Eco-techno literacy to become a resilient bio-culture 252

5.2.1.1 Concious resilience practices...252

a. Gentle Action and the frugality factor: Defuturing technology to achieve resilience 257

b. Hoping for 'good' design: The ethics of positive future scenarios 261

c. Shared Vision: Interdisciplinarity to achieve resilience... 265

5.3 The Legacy of rethinking design in a resilient planet: Reflective Phase 268

5.3.1 Resilient Design as Planetary Ethic: Preparing towards symbiosis 268

5.3.2 Foundations: The character of the resilient design thinker 269

Chapter 6. Symbiotic Design Practice: Becoming with-in our living world through design 273

6.1 Transcending togetherness: Designing symbiotically 273

i. The Symbiotic Worldview: Igniting a Symbiotic culture 273

ii. With and within nature: Reconciling the idea of designing together with our planet 280

6.1.1 Symbiotic design as legacy (Prime Output)... 284

a. Our bioculture: Symbiotic Design as philosophy for a new cultural shift 279

b. The metamorphosis of the ecodesigner of the 21st Century: Integrating eco-techniques...289

c. The ecological journey: Learn to trust the process, not the output....294

6.1.2 Becoming with-in nature through the Symbiotic Design Practice.... 302

Chapter 7. General Conclusions 306

7.1 Designing with-in nature 306

7.1.1 A new ecopedagogy for Design 307

7.1.2 Ecopedagogical Structure 308

7.1.3 A symbiotic design model for the XXI century 310

7.2 Further steps and dissemination 313

Epilogue.`....315

Bibliography 318

Research explorations....367

Appendices....399

List of Figures

Figure 1.Ecological Wisdom 20
Figure 2. Bio-Synergistic dynamics 37
Figure 3. Development of metadesign disciplines (Inns, 2007) 39
Figure 4. The 4-phase representation of the Action Inquiry Cycle (Tripp, 2001) 49
Figure 5. Research Question Process 50
Figure 6. Designing with-in-nature dynamic 51
Figure 7. Integral Theory Quadrants by Wilber (2000) 53
Figure 8. Four terrains of Symbiotic Design 53
Figure 9. Symbiotic Design Practice Framework (mandala) 54
Figure 10. Design Thinking Process Model by Stanford D. School (2013) 56
Figure 11. Double Diamond Design Process Model by Design Council UK (2011) 56
Figure 12. The Symbiotic Design Practice (SDP) process 57
Figure 13. Symbiotic Design Practice node 61
Figure 14. Research process (Action-Based) 63
Figure 1515. Method rationale 65
Figure 16. Biophilia Awareness Stage 78
Figure 17. Images of biophilic tendencies 89
Figure 18. Biophilia Understanding Stage 116
Figure 19. The biophilic being foundations 140
Figure 20. Biomimicry Understanding Stage 142
Figure 21. Biomimetic Architecture Examples 174
Figure 22. Bio-design Cube by Tom McKeag (2013) 184
Figure 23. Biomimicry Action Stage 186
Figure 24. The 'biomimetic practitioner' foundations 209
Figure 25. Resilience Action Stage 210
Figure 26. The Four Principles of Sustainability (Mitchell cited in Palmer et al., 1997) 216
Figure 27. The use of the term sustainability (Palmer, 1997) 216
Figure 28. Planetary Boundaries (Rockström et al, 2009) 223
Figure 29. Resilience Doughnut (Raworth, 2012) 224
Figure 30. Doughnut and the planetary boundaries (Raworth,2012) 225
Figure 31. Panarchy dynamic (Gunderson and Holding, 2001) 225

Figure 32. Three level panarchy (Gunderson and Holding, 2001) 226
Figure 33. Temperature variability on Earth and the Holocene (Rockström et al., 2009) 241
Figure 34. Futures methods and techniques 244
Figure 35. Resilience Legacy Stage... 247
Figure 36. Energy Futures by Holmgren (2009) 264
Figure 37. The 'resilient thinker' foundations 271
Figure 38. Shanghai in 2100 by Luc Schuiten. 291
Figure 39. Lilypad Habitat by Vincent Callebaut 291
Figure 40. Gardens by the Bay Singapore (various firms) and Biodiversity Bridge Netherlands (unknown author) as examples of symbiotic designs 292
Figure 41. Ecotechniques and the integral levels 295
Figure 42. Students at the Dundee Botanic Garden facilities 370
Figure 43. Students doing sensing activities 372
Figure 44. Postgraduate students in the mindful meditation session and mindful movement with Kumanga Andrahennadi. Picture credits (Andrahennadi, 2013) 373
Figure 45. Students in a walking meditation... 375
Figure 46. Students practicing the Goethean Method individually and in a group..............377
Figure 47. Students in deep conversation with a non-human being 378
Figure 48. Students doing observations and collecting samples... 379
Figure 49. Visual presentations by the researcher 380
Figure 50. Images of students learning biomimicry methods... 381
Figure 51. Students using research templates 383
Figure 52. Sample of students' material for collecting biological information 385
Figure 53. Sample of students' conceptualizations and prototypes.................................... 386
Figure 54. Students participating in resilience thinking activities 387
Figure 55. Students' interaction with the 'resilient island' activity 390
Figure 56. Students working on Forecasting activities 391
Figure 57. Students self-evaluating their final design proposals 392
Figure 58. Former and final template 7 on thinking about our bioculture........................... 394
Figure 59. Students enjoying the 'Metamorphosis' activity 396
Figure 60. Postgraduate students evaluating activities and teaching material 398
Figure 61. Students presenting their final projects and learning journeys.......................... 398

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To our Mother Earth.

Declaration

Unless otherwise indicated in the text or references, this thesis is entirely the product of my own scholarly work. Unless otherwise stated, all references cited have been consulted by the author. The work, of which this thesis is a record, has been created by myself and I have consulted all the references cited. The thesis has not been submitted for a higher degree at this or any other university or institution.

David Sánchez Ruano July 2016

Autobiographical Statement

Here I am, another inhabitant of this planet who has decided to question the creativity of the human intellect and the passion that drives us to look for a future in tangible, ecological and educational ways through design. Why am I concerned about these issues? Why did I choose Scotland to look for answers? Many events have shaped my life and given me the desire to seek more knowledge through a PhD study. Unexpected events, a few years of teaching at postgraduate level and especially sharing dreams and ideas with my mentors and loved ones were the stimulus, which has steered me to this wonderful region of the planet.

I was born in a small village in central Mexico in the region of Los Altos de Jalisco, near the border of Zacatecas. I grew up in a family of farmers in the village of La Estancia, in the municipality of Nochistlan. As the youngest member of a family of five, I was the one who was lucky enough to continue my studies despite the adversities Mexico faced in the 1990s. During my childhood, I learned to farm from my parents, siblings and the community, who all responded to the rhythm of the rain season fully lived on the land. Harvesting maize, herding cattle and processing pork meat with vernacular devices such as manual mills, ploughs and machetes now represent, for me, a great knowledge, sensitivity and formation as designer and craftsman.

Living in the country always inspired me to explore the meadow hills and the streams. Observing orange belly tortoises, chasing fireflies, climbing mesquite trees and playing with clay with my friends are wonderful memories that I will cherish throughout my life. Nevertheless, a wind of sadness has appeared suddenly; the meadow hills are eroded with a few mesquite trees fighting for survival; and the streams where I used to swim have lost their color. My nephews can no longer see the 'torito' beetles that I used to chase; they do not know how to farm and the sense of play in the wilderness is blocked because they prefer the videogame console.

During my teenage years, I was educated in a tele-secondary school, a programme launched by the education council to reach distant and underserved small communities. Through satellite dishes, pre-recorded programs and one single teacher, everything looked like I was making good progress. After that, however, everything was uncertain. Many of my peers, as inheritors of a town of migrants, departed to the United States or nearby cities after they finished high school. The contact with my uncles and brothers, by then living in California, undoubtedly influenced my future plan to live there. I had the chance to visit Los Angeles during those years but freeways, shopping malls and theme parks all exhausted me.

Also during my teenage years, my mother's creativity in caring for plants and trees in her orchard, the use of reclaimed materials, making clothes, cooking and creating fixtures for every corner of the house were a great influence to me; her 'inventions' and then my 'inventions' always surprised the members of my family and the neighbours in the village. Glass bottles, acetate discs, murals, collages, antique restoration and many other things also began to create a design path.

The opportunity to attend a new high school just a few miles from my hometown was much more interesting than the 'American dream'. Then, with the positive guidance of teachers, I became interested in speaking English, computing, biology, regional dance and crafts. During my last year, I volunteered to work at a school for adults, most of them in their 20's or 30s who did not have the chance to go to secondary school. It was there, I believed, that I acquired my desire to share knowledge and become an educator. Finally, and as the only option at that high school, I receibed a diploma in Accountancy, which did not appeal to me at all.

My desire to keep learning took me to a decisive moment in my life. My parents and siblings supported my decision to apply to university without questioning my career choice. The easiest way and also because of the economic situation, was to apply to the nearest university, in this case the University of Aguascalientes which is right in the geographical centre of my country. However, because I was from another state, the only options to choose for a degree were the ones with medium demand, in this case English teaching, IT, Urbanism and fortunately one that immediately caught my attention: Industrial Design. I clearly remember that a few weeks before applying, I was putting cuttings in my notebook from a popular science magazine. One of the pictures I was cutting out was a circle, half of it a flower corolla and the other half almost the same but in stainless steel. This figure came precisely from an article entitled: "Industrial Design, the Career of the Future". Words in the article describing objects, materials, shapes, pleasurable experiences in everyday life, along with that image, stayed in my mind, which then dictated my destiny.

The first years at the University were a challenge, yet new friends and city life became enjoyable as well as very entertaining with the mixture of drawing techniques, workshop machines, mock-ups and digital techniques I started learning. Explaining to people what exactly constituted being an industrial designer was always an eclectic exercise: 'I design artifacts for factories!'... 'Ah! You invent machines?' they always replied. In the end, my explanation was always simple and changed according to whom I was speaking to: 'I learned about all the materials and their characteristics in order to suit a company's manufacturing requirements, making them more aesthetic and cheap to produce!'

During those years, certain tendencies to care about the "environment" came about. Nevertheless, the ecological and ethical ways of designing were not on the curricula. The words 'innovation', 'marketing', 'icon trademarks' and 'famous designers' appeared as ways to become a good designer and compete in a globalised market economy, a world that did not really appeal to me. One of my favourite things that I really enjoyed was the making of a vehicle model inspired by a wood wasp. A wonderful concept came to me: transparent wings, antennae, color reflection along with an infinite microscopic world where hexagonal eyes, furry legs and sensory systems signalled a more in-depth study, nevertheless no chance to focus on that at this time! Toward the end of my bachelor studies, the educational system, especially in regards to employability, focused primarily on marketing, entrepreneurism or a career in local industries.

During my internship, I had the opportunity to work in a small workshop designing furniture, merchandising displays and signs. On one occasion, the opportunity arose to design equipment for a new exhibition about insects at the Descubre Science Museum (Aguascalientes, Mexico). They asked for the design of a giant "drosera" (a species of carnivorous plant). Creating curved shapes, leaves and sticky tips was again an experience that I certainly enjoyed; nevertheless, there was also toxic plastic foam and plaster in between! Although this was a nice project, I continued asking, 'why that structural stem?

What is the function of that sticky substance?' and other information related to the organism that were never questioned deeply. For some reason, I knew that there was something with great potential waiting to be discovered.

In 2006, I decided to move to another city looking to get experience as a professional designer in a company. The opportunity arose in the city of Guadalajara, Mexico in a kitchen design studio. 3D visualization of interior spaces, proposing materials, recommending fancy imported appliances and managing budgets were some of the skills I acquired related to design. However, this design role did not meet my expectations or life ambitions. In my spare time, as a freelancer, I also had the chance to develop projects with marketing companies and education institutions, designing equipment and awards for special events. My desire to continue learning more about design and its ecological purpose then became very appealing to me.

I decided to apply for the postgraduate programme in industrial design at the National University Autonomous of Mexico (UNAM), the most prestigious higher education institution in Latin America. There I came across a research area in Eco-technologies, which immediately drew my attention. Reading about ecological materials and ways of making locally influenced me to write a proposal around the concept of "glocalism" and sustainability trends in design. On being accepted, my studies commenced in the summer of 2007 by moving to Mexico City, known today as one of the biggest cities in the world.

After the first two months and as a recipient of a scholarship from CONACYT (National Council of Science and Technology), the broad idea of sustainability was readdressed into a practical response to the institution. The first ideas focused on packaging design and the cradle-to-cradle principles. Some of the initial research inquiries included questions such as: how can we design better packaging that reintegrates into nature? How can we apply the concept of waste equals food? Suddenly, plant seeds, eggshells and different kinds of packaging models found in nature redirected my research into a completely new and immediately fascinating area: Biomimicry started to gain interest in the design community as a way of achieving sustainable designs. The term contained an ecological dimension and a biophilic one that at that moment was absent.

Nevertheless, at the beginning of my Master's studies, a myriad of concepts around mimicking nature's wisdom redirected my research into an interdisciplinary exercise from biology to engineering sciences. The term biomimicry began to appear in different strands for industrial design and engineering practices under the synonym of bionics and biomimetics. An opportunity to attend a meeting on biomimetics organized by the University of Bath and the University of Reading arose in the first semester of my Master's degree. By coming to the UK, I had the chance to meet experts and followers of the discipline from different organizations around the globe led by Professor Julian Vincent, founder of the Centre for Bioinspired Technologies. In this meeting, I could not find the answers that I was looking for.

Finally, in the summer of 2008, I was very fortunate to attend another conference called Design & Nature IV, organized by the Wessex Institute of Technology in Portugal. It was there that I first made contact with Terry Irwin, one of the members of the Centre for the Study of Natural Design (CSND) at the University of Dundee and now Head of the School of Design at Carnegie Mellon University in the US. In the last session, she presented a paper entitled "The dynamical view of form" where concepts like holistic design, Goethean science and deep ecology displayed a much more sensitive and complete approach to biomimicry. Looking to find out more about these topics, I asked for a chance to establish a research link with this university. It was then that Terry suggested I speak to my future mentor, Professor Seaton Baxter.

Thanks to the funding of my sponsor CONACYT, the support of PDI-UNAM members and the unconditional response of Professor Baxter, I had the chance to come to Dundee in the winter of 2009. Finally, after being at CSND for almost five months, I had the chance to touch the philosophical ground required for my research. During that time, my conversations with the members of the Natural Design Group, and the talks that I delivered to undergraduate students and other forums at DJCAD, established my desire to continue in academia and pursue a PhD. The encouragement to return was expressed by Professor Baxter, although I would need time to look for funding opportunities back in my home country.

On my return to Mexico, I also felt a need to share what I had learned in CSND and expand the focus of my dissertation, no limit it only to biomimicry. I felt very confident in what I acquired and before finishing my Master's degree, I proposed to teach a new module for the postgraduate programme. Luckily, at that time, the faculty was looking for an optional module to strengthen ecological thinking and the practical aspect of eco-design at the same time. The module I proposed was entitled Biomimicry and Holistic Design, framing concepts such as biophilia hypotheses, salutogenesis and other eco-philosophies studied during my visit to CSND. This module was well-received and, in the second year of teaching, I felt the need to expand it, and proposed a second module called Biomimicry Workshop. Eager to explore more about the topic along with the Masters students, I had the idea of organizing experiments and field trips along with the Biology faculty at UNAM.

One of the milestones in my life as a design teacher was a field trip that I organized to visit Los Tuxtlas biological station (a natural reserve at the tropical forest, south Mexico). This was one of the most extraordinary and complete experiences for me and the Master's students with whom I was interacting. Immersed in the rainforest, trying to reabsorb all the theoretical knowledge in that context brought a general consciousness as we felt the vivid natural interactions. The discussions of design issues surrounded by noises of insects, monkeys and birds made me realise something: I needed to explore aspects beyond biomimetic design and ways of teaching to see nature through a different lens.

I came to the realization that finding ways of expressing our capacity to thrive with just our own human centeredness needed to be questioned more deeply. And here I am expanding those questions, all brought to notice by many experts such as David Orr, E.O. Wilson, Stephen Kellert, Victor Papanek, Freya Matthews and John Michael Greer, who have been advocating a need for a new industrial revolution, new ways of education and a societal transition through ecological design.

And here I am in Scotland, a land that has given birth to great minds who have inspired society to explore ecological ways of designing and to understand what nature can teach us. D'Arcy Thompson, James Bell Pettigrew, Patrick Geddes, James Hutton and John Muir were great naturalists, with deep concerns about the patterns of nature, always looking to compare human actions with the actions of other living beings, an exercise that nowadays is still developing. It is a privilege to be in this very place like them. Fortunately, I am one of the last postgraduate students that came to study at CSND. Sadly, the Centre has closed down, but fortunately a few of us, part of the Natural Design Group, have now become spores that keep spreading the ways of ecological thought in design.

To conclude the writing of my thesis, I had the opportunity to move to Schumacher College, one of the epicentres of ecological thought. Many wonderful things occurred during my stay. One of those was the chance to teach in the MA in Ecological Design Thinking in its first year and second year. There, I had the chance to share and put into practice what I have implemented during 3 years of this research. I concluded that I had become an ecological design educator and that my path was now clear.

I hope that my proposal will help to activate the inner human naturalistic capacities that every individual has to understand nature's design, creatively and holistically. Seeing the pattern that connects from genes to hurricane formations, not only deepens how creative we are as a species but how wise we can become when we learn to translate nature's language. I am now convinced that to become a facilitator of nature-based design methods and experiences can inspire ethical intentions to co-create a flourishing planet. This bio-cultural shift helped me to recognize who I am. Proudly, I can say that I have become a biophilic designer, a natural pattern seeker, and also an interconnected symbiont of an ever-changing world.

Abstract

Human culture has recognized the damage being caused to our environment and is in the process of transitioning toward sustainable systems. Design disciplines and environmental studies are engaging in alternative ways to support a sustainable world and, to a large extent, on resolving the disconnection between humans and nature. The conceptualization of *Symbiotic Design* proposed in this research, facilitates theoretical-practical reflections and recognizes that learning through closer association with the natural world can trigger innate responses and enhance human creativity. Designers need to have an understanding of these concepts to allow them to design in an ecologically conscious way.

Using biophilia, biomimicry and resilience thinking as core eco-techniques, the research develops a series of teaching/learning practices that aim to enhance the embodiment of design with-in nature. This *Symbiotic Design Practice* process was developed, tested and evaluated across a sample of undergraduate and postgraduate design students. Text, visuals and workshop activities evolved through a method of action-based cycles. In essence, the research proposes a new eco-pedagogical strategy that facilitates nature-based experiences and behavior change toward an ecologically conscious design culture.

Preface

Many people in more prosperous parts of the world recognize the planet is facing a convergence of many crises, including the potential effects of climate change, loss of biodiversity, air, water and soil pollution, population growth, social inequality and financial instability, all of which are seen as challenges to their well-off, secure lives.

Millions of others at the lower end of the poverty scale, however, are only aware of these "so called" crises when they have a direct effect on their daily lives. For example, when rising sea levels, due to climate change, inundate their crops and homes or submerge the whole island on which they have lived their whole lives.

Therefore, the concerns about global crises are neither equally well perceived nor unanimous in their acceptance, and this does not account for the deniers of some or all of these apparent crises. Nevertheless, in total, they exist and need to be confronted before they worsen and before the dangerous trends becomeirreversible. This is of course happening. For instance, natural scientists are concerned with measuring the magnitude of the problems, social scientists are working on community effects, political economists are examining policies and designers…?!

What are designers doing? Well, many have already changed their perspectives to embrace the objectives of sustainability, others continue to adapt their practices when they are presented with suitable problems, but many are continuing with "business as usual". The problem of design itself lies in our capacity to recognize our intentional power but also in our incapacity to comprehend the real context that we live in, the Earth.

New opportunities for creative engagement have materialized in the way we integrate design in society. Design is transforming from traditional product development to intangible interrelationships, which involves new ways to embrace technology, societal interactions or co-designing with others requiring emerging roles in the designer. The work here correlates to these interrelationships at both socio-economic and ecological levels.

Designing ecologically is constant and subversive, and is not to be considered as a 'hybrid' (Dykes, et al 2009) contemporary practice. It can be a permanent, embodied part of the designer and its relationship with the living world through thinking and acting.

Two levels position this work in the diverse context of contemporary design practice. The first is at the meta-level, the level that sits above and should guide all future ecological design practices. This is the notion and the practice of ***Symbiotic Design*****,** where all design practices should operate in a symbiotic way with the more-than-human world. The second is at the operational level, which contains the three elements of my work as **Biophilia, Biomimicry and Resilience.** All three elements, when integrated, produce the meta-level but they can be applied singly or in combination at the operational level in appropriate practices. For example, a practice may already operate at the resilience level but may not yet have embraced biophilia and biomimicry which are strong ecological actions and which would be necessary to operate at the symbiotic meta-level. Another example may be an organization that uses biomimicry and resilience but has yet to absorb the biophilic philosophy and moral position needed to guide the appropriate use of ideas and products from biomimicry. The selection of some or all of the operational concepts allow a wider range of contemporary design practices to balance their working operations in stages to reach the meta-level and designation of *Symbiotic Design*.

This thesis concentrates on design and designers and on those issues that are perceived to be in their working domain, including the potential expansion of the domain as it yields to the contemporary view of "design thinking." However, it directs its major attention to design education in its broadest sense with the aim of creating a new generation of young designers who, the research proposes, will become the "symbiotic designers" of the future.

As a brief overview, this study consolidates the theory and practices of biophilia, biomimicry and resilience thinking in order to develop a series of teaching/learning strategies and practices which enhance the embodiment of 'designing with-in nature' or *Symbiotic Design*. This thesis is divided into seven chapters. Chapter 1 provides an indication of the design epistemology, and its links with ecological thought, in the understanding that a holistic curriculum and ecopedagogy are needed in design. Chapter 2 discusses the research methodology and methods that underpin the study of a new ecopedagogical framework.

Chapter 3 explains how to reconsider our innate need to learn from nature through the concept of biophilia. Chapter 4 indicates the strategies to learn and implement biomimetic design. Chapter 5 integrates the concept of resilience as a way to evaluate cultural behavior and change along with the patterns of nature. Chapters 3, 4 and 5 are integrated as core foundations that relate to Chapter 6, where the concept of *Symbiotic Design* is discussed and integrated as a practice. Finally, Chapter 7 offers some general conclusions, provides a description of further steps to implement a new design curriculum and explores a method of *Symbiotic Design*.

Chapter 1. Designing for a living planet (the meta-context of design): Introduction

1.1 An ecological turning point in design

Most of the problems that we face in the world today are not only related to an inheritance of badly designed human systems but also to the apparent lack of any appropriate ethical decisions behind them. Examples of these areas requiring strong ethical considerations include the relationship with our natural 'environment', the diversity of populations and their worldviews,[1] and the boundaries we impose on our creative power of making and exploration. How can we find a new balance in our way of life at the beginning of the 21st century? What are the key ecological practises that are pushing our society to wake up, to make the difference, to be sustainable, to be abundant, to thrive and to accept change naturally?

At stake in today's crisis is the narrative of systemic change that drives human civilization, deduces Eisenstein (2011). We can interpret these systems as layers that flux, collide and connect with complex manoeuvres and relationships. Indeed, many of today's problems have come about from our fragmented view of the world and our inability to foresee the interconnections and the relationships that hold our systems together (Capra and Luisi, 2014). These kind of "wicked problems" that exist today as climate change, pollution, economic collapse and loss of biodiversity, progress depending on the language, ethnic background, profession or expertise being reflected. These kinds of layers are embedded in a bigger, finite and ever-changing system that we think we can control, but that we can really only try to know more deeply, to understand and cope with and ultimately to fall in love with our only home: Planet Earth.

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[1] A **world-view** or worldview is defined as 'the coherent collection of concepts and theorems that must allow us to construct a global image of the world, and in this way to understand as many elements of our experience as possible (Aerts et al., 2002). Vidal (2008) argues how philosophy and worldview are closely related. In his view, a worldview is the highest manifestation of philosophy and offers a kind of universal validity. In this study, an ecological world-view (view of the world, perspective or lens) is about becoming attuned with a more-than-human world.

There is no realistic foreseeable future for the human species on this planet without a flourishing natural environment (i.e. other living species and their ecosystems, referred to here as 'Nature'). Of course, the human species is part of nature but is it currently playing an appropriate *symbiotic* role? In planetary evolutionary terms, the human species is less than an infant, potentially bright, disruptive and mainly interested in playing with their latest techno-toys, oblivious of how all this affects what is going on around them.

Nowadays, those working in the field of biotechnologies proffer a scenario in which self-organizing robots (Murata et al., 2012), living buildings (Armstrong, 2012) and high-performance humans (Rifkin, 1999) will reach meaningful lives through self-regulated artificial environments. Nevertheless, conscious of the many concerns about manipulating genes, consumerism and industrial dependence, there is another possible world of low-technological advances and sustainable developments that portray a harmonic descendent rhythm (Greer, 2008) and a transition to resilience and sustainability (Hopkins, 2011). Here, an altruistic human sense of permaculture (Holmgren, 2002), eco-literate communities (Goleman et al., 2012), zero waste industries and local craftsmanship seeks to change those technologies that have been upsetting 'our natural environment'. This altruism is a realization of the human spirit that is now looking to maintain healthy levels of interrelationships, in its inner and outer ecology.

It is also suggested that we are now shifting from a mechanical-object ethos to an organic-system ethos and, as such, we must figure out the role of design in an age of biology (Dubberly, 2008). This age, as Dubberly identifies it, will create new industries, bringing about profound cultural shifts and many new changes in our view of the world and our place in it. This notion raises the need to promote a clearer vision of ecological practices, in order to develop a deeper understanding of our biological functions and the way we create technologies. In essence, a new approach to design.

Nature freely services this planetary system, in a way unsurpassed by human achievement. It creates the oxygen we need to breath, reduces the toxins in the soil, air and water, prevents erosion, restores its resources and provides us with an ultimate source of wonder and aesthetic pleasure. Not only is nature the source of such essential services but its long evolutionary process provides us with a vast source of tested knowledge. Explicating this knowledge is critical to designing a mutually satisfactory and flourishing co-evolutionary global system. Philosopher and ex-minister Vaclav Havel declares:

> *'We must draw our standards from the natural world. We must honour with the humility of the wise, the bounds of that natural world and the mystery which lies beyond them, admitting that there is something in the order of being which evidently exceeds all our competence'.* (cited in Benyus, 2002)

Therefore, our culture needs to establish a permanent dialogue with the natural world in the pursuit of answers for the realization of our contrasted design utopias. Clearly, we need a new approach to design and the use of ecological techniques might play an important role in starting such a dialogue. This need situates the design academy as the embryo from which to begin the development of such strategies in order to create meaning and hope in the making of the future in an *Age of Enlivenment* (Weber, 2013).

1.1.1 On learning how to become humans by thinking ecologically

What we are now experiencing is a dramatic increase in political wars, poor health conditions and crime, to name a few examples. To some extent, it is a symptom of what we ourselves have created around us. These experiences and preassures are trying to inform us about the need to change along with the living patterns of the Earth. Respecting and becoming one with the living world, as a philosophy of life, requires an immediate collective effort. As we achieve this change in our worldview, a reconstitution of our culture might take effect, from educational institutions to industrial practice.

In nature, we can find some of the answers to becoming human by comparing and mimicking her wisdom. It is in the constant recreation of life and death cycles, interconnectedness of systems and being mindful of our human gifts, is that the world is trying to show us?. If nature made humans through its constant adaptations, regenerations and collapses, then we need to acknowledge and teach that same dynamic.

Learning how to *become the world* or to *consciously feel* the living world as a design epistemology implies going deep in thought, deep in research, deep in ecology, and it is 'learn to unlearn' (Baxter, 2013). The acquisition of this philosophy of 'becoming with the world' in the design academy might be one of the biggest challenges of our time.

Influenced by history and the present achievements in science and technology, facing the future is not an easy task, especially for the designer who is constantly aiming to invent new artefacts. While living in the present can be our only comfort, the aspirations we imprint and expect in future generations are sometimes more powerful. The academic literature from prominent minds, such as Stephen Hawking or James Lovelock (in Aitkenhead, 2008), as well as reports from thinktanks like NASA and other research institutes around the world (Centre for the study of existential risk, 2014), forecast a collapse of our civilization in the coming decades driven primarily by our "business as usual" anthropocentric way of life.

Back in the 1960s, emphasizing ecological perspectives along with the role humans play in society, Shepard (1969, p. 1) suggested that 'man is *in* the world, and his ecology is the nature of that *inness*'. He also explained that 'the wisdom of ecology is universal and can be approached mathematically or chemically, or it can be danced and expressed as a myth'. Indeed, being 'ecological' is still commonly understood as describing a metaphysical aspect and/or a response to a political philosophy on nature (Curry, 2011, p. 4). These affirmations represent a need to respond integrally and in mutual feedback to our biology. It also signifies how our culture of separation of the sciences and humanities is now beginning to be reconciled through alternative ways of education, where ecology and naturally inspired design is keeping alive the naturalism we have lost.

As we dream to synthesize food, terraform other planets or have personal robots to do our duties, we can still explore the benefit of our technological ingenuity to support nature. Technology is not a violation of nature. Einsenstein (2013) usefully captures this belief, saying 'what we need is to embrace and be critical with that human gift [...] and certainly use it as in the spirit of a gift'. That humbleness comes when 'we see the soul of Nature - its purpose, intelligence and *beingness* and this comes not from without but from within' (ibid). Substituting those gifts by mimicking nature is not the key; it is our *symbiotic consciousness* (see Section 1.3 and Chapter 7) that is important. From a design educator's perspective, we need to provide meaningful narratives and intuitively feel the appropriateness of our designs in order to nurture and sustain our planet. Such a teleological approach is a paradox for scientists and sceptical designers.

At the beginning of the 21st century, our human-centeredness is open to questioning now more than ever. We form part of a bigger whole - a universe of life that gives us self-esteem and confidence that follows the mutual collaboration to create conditions of life on this planet, described here as *symbiotic consciousness*. We have begun to understand the Earth as a living being (Lovelock, 1979), and to understand our bodies and actions as a set of relationships with other bacterial organisms (microbiomes) or ecosystems (macrobiomes) to create conditions to live. With such a choreography of life, we have begun to build a self-realization of how the complexities of nature are organic extensions of each other and everything we create.

Shepard (1969. p. 10) provides us with some clues as to what ecological thinking means:

- 'It need not be incompatible with our place and time.
- It does have an element of humility that is foreign in our thought, which moves us to silent wonder and glad affirmation.
- It gives an essential factor, like a necessary vitamin, to all our engineering and social planning, to our poetry and our understanding.
- There is only one ecology, not one human and another sub-human.
- No school, theory, project or agency controls it.
- For us it means seeing the world as a mosaic from the human vantage without being man-fanatic.
- We must use it to confront the great philosophical problems of man – transience, meaning and limitation – without fear.
- Affirmation of its own organic essence will be the ultimate test of the human mind'.

Drawing upon these principles, it appears that the epistemology of design is in a constant state of transmutation. We are on the verge of an Ecozoic era,[2] where the greatest challenge is the process of redirecting education to play a more active role beyond historicity and humanization. It is about encountering our symbiotic consciousness and belonging to the 'Great Work' (Berry, 2011) that we are creating together as bio-civilized symbiotic creatures.

1.1.2 The Way of the Ecological Designer

Design has a major role to play in contributing to the resolution of the unprecedented problems we are confronted with today. Design, in its broadest sense, means '*solving for pattern,* creating solutions that solve many problems' (Wendell Berry in Orr, 2009). While the meaning of design ranges from creativity to planning, it can also act as a system integrator, which is called 'metadesign' (Inns, 2007, p. 114). Wood proposes that this notion of metadesign is needed, as other ways of designing, such as 'design for sustainability', are failing to meet the needs of society (cited in Inns, 2007, p. 116).

Brown (2009, p. 86) defines design thinking as 'the discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable strategy can convert into customer value and market opportunity'. Reworking these remarks to refer to 'ecological design thinking', we can define it as the *philosophy that develops the designer's sensitivity and ways of knowing to respond to the interrelation of human and non-human needs by questioning ethically what is valuable to design for the whole*. As we transcend the fragmentation and the disorder caused by our industrial civilization, we are clearly looking for new philosophies for design. Learning *with and within nature*, as is proposed throughout this research, might help us find a focus.

Ecological Design transcends generic design skills and requires us to maintain collective intelligence to solve problems (Orr, 2004a, p. 9). This research thesis is framed on an

[2] Ecozoic: a time period in which we are witnessing a massive transformation between a communion with the cosmos and with ourselves which forms part of a larger universal community.Thomas Berry refers to it as the Great Work (2011).

ancient wisdom of ecology and responds to recent associations with the concept of symbiosis: 'what nature gives to us is influenced by what we give to nature' (Deloria cited in Orr, 2004a, p. 11). In the same way that ecology combines field-based research with theory-building, it crosses boundaries from academic to the non-academic; constructs like 'symbiosis' or 'adaptation' readily become a *comprehensible* (Borden and Collins, 2014, p. 278) part of the operating vocabulary.

Therefore, it seems that the definitions and related principles of ecological design are framed to transcend our worldviews by learning from nature. For example, Orr (2004a, p. 20) defines Ecological Design as 'the careful meshing of human purposes with the larger patterns and flows of the natural world and the study of those patterns and flows to inform human actions'[3]. He also explains how Ecological Design must become a kind of 'public pedagogy' built into the structure of daily life (2004a, p. 31).

John and Nancy Todd (1984) propose the following ecological design principles that may resonate with the formation of such a pedagogy:

- 'The living world should be a matrix for all design.
- Design follows, and does not oppose, the laws of life.
- Biological equity determines design.
- Design must reflect bioregionality.
- Projects should be based on renewable energy sources.
- Design should be sustainable through the integration of living systems.
- Design should be co-evolutionary with the natural world.
- Building and design should help in healing the planet.

Design should follow a sacred ecology.' The principle that particularly expresses the philosophy behind this thesis is "Design should be co-evolutionary with the natural world". This clearly supports the concept of *Symbiotic Design* (See section 1.3 and chapter 7).

[3] For more definitions see Glossary: Ecological Design explanations by Orr (2004).

One of the most influential ecological designers,[4] William McDonough, reflects on the need for a resetting of ethical values, asking: 'How can we love all of the children, of all species, for all time?' (Braungart and McDonough, 2009). Since his participation in the formation of the *Hannover Principles*, it has been realized that there is a need to go beyond sustainability by proposing a *cradle-to-cradle* standard as a way of designing where everything is considered as food, subject to using clean energy and a celebration of diversity. Such a change of values evokes a new paradigm, for example, seeing materials as biological nutrients and being integrated as technical nutrients. The Hannover Principles represent a living document committed to the transformation and growth in the understanding of our interdependence with nature:

- Insist on the rights of humanity and nature to co-exist.
- Recognize interdependence.
- Respect relationships between spirit and matter.
- Accept responsibility for the consequences of design.
- Create safe objects of long-term value.
- Eliminate the concept of waste.
- Rely on natural energy flows.
- Understand the limitations of design.
- Seek constant improvement by the sharing of knowledge.

These principles have had an important influence on the development of ecological design schemes. In one of his latest presentations, MacDonough (2014) concludes that 'we may be here to heal the Earth, but at the end the Earth is here and heals us at this point of human history'. More recently, Van Der Ryn (2013) has presented several ecological thoughts for the designer to help in the development of a new empathic worldview toward the path to symbiosis:

- Move away from a totally human-centred view of the world.
- Understand the synergy between nature and human nature.
- Appreciate the connectedness of the whole.

[4] In this study, the **Ecological designer,** or Eco-Designer, is the individual that is capable of understanding interconnections of actions for the wellbeing of our planet. In this study, the idea of the Symbiotic Designer could be interpreted as a synonym but at a more sophisticated level, in which one is able to integrate Ecology and all its contemporary connotations and postures.

- Use principles of living systems in our work as architects and ecological designers.
- See ourselves as continual learners and avoid hubris.
- Encourage dialogue and ask deeper questions especially when challenging accepted ways of thinking and doing.
- Recognize the role of spirit and love in everything we do.

One of the most complete definitions of Ecological Design is provided by Orr in his seminal book *The Nature of Design* (2004a, p. 32):

> *'Ecological design is the art that reconnects us as sensuous creatures evolved over millions of years to a beautiful world. That world does not need to be remade but rather revealed. To do that, we do not need research as much as the rediscovery of old and forgotten things'*

Furthermore, Orr (ibid) identifies a beautiful ecological philosophy (ecosophy) of design:

> *'Our greatest needs have nothing to do with the possession of things but rather with heart, wisdom, thankfulness, and generosity of spirit. And these virtues are part of larger ecologies that embrace spirit, body, and mind — the beginning of design'.*

Contemporarily, the meaning of design is shifting from the development of tangible aspects such as objects, images and constructions, to include the non-tangible aspects like processes, services, planning and the representation of ideas. It is also embracing different connotations such as framing, drawing and, one of the most powerful and ethical meanings, *intention*.

Intentionality is a problem of human ecology (Orr, 2004a, pp. 15–32). As we try to solve our problems by creating greater abundance, we, at the same time, have lost our character (Berry, 1978), become disenchanted (Berman, 1998), and lost our sensual connection to nature (Abram, 1997). With exponential growth (Meadows et al., 2004), and flaws in the economic system, we realize that immoderate iteration of technologies has created ecological problems which we identify as design failures.

Orr (ibid) argues that this kind of bad news for design 'may signal inherent flaws in our perceptual and mental abilities. On the other hand, it may be good news. If our problems are, to a great extent, the result of design failures, the obvious solution is better design, which means a closer fit between human *intentions* and the ecological systems where the results of our intentions are ultimately played out' (ibid, p. 14). Here we have defined design as an intention, and it is in this philosophical construct that the ethical identity of the designer rests.

Orr (2004a, p. 180) has also suggested that design is 'focused on rationality in its largest sense, giving priority to the wisdom of our intentions, not the cleverness of our means'. As we become more and more dependent on our anthropocentric prowess, our ecological wisdom begins to be questioned. This inquiry presents ecological design as a redeemer of coherence and lifts our spirit of intent. As our intentionality tends toward the ethical and the spiritual, we are in a constant search for meaning an d new values. The exercising of ecological design is leading us to connect human meaning within a Gaian strategy, thereby recalling human behavior back to our original instructions.

Regarding our cleverness as Homo sapiens, Orr (ibid, p. 25) claims that 'we need a more sober view of our possibilities. Real wisdom is rare and rarer still if measured ecologically. Seldom do we foresee the ecological consequences of our actions'. With this in mind, we need to reconsider our role as a species and generate a new design ethic. As we design with ecology in mind, harmony between intentions enables us to establish a bond between our bodies and our planetary culture. With ecological design, we offer room for old wisdom and the new, to rationalize our contemporary culture.

Ecological thinking 'is not simply thinking about ecology or about the 'environment' [...] It is a provisioned mode of engagement with knowledge, subjectivity, politics, ethics, sciences, citizenship and agency that pervades and reconfigures theory and practice. It is not reduced to a set of rules or methods, and it operates in a different way, from location to location. It is sufficiently coherent to be interpreted and enacted across widely diverse situations' (Code, 2006, p. 5). Code adds that ecological thinking is as available for 'feeding self-serving romantic fantasies as for inspiring socially responsible transformations'(Code, 2006, p. 6). This kind of paradoxical discourse of conflict and peace adds tension to the debate but also creates its strength.[5] This is why, in the design academy, implementing ecological design courses is the innovative force that can re-engage the meaning of intention. Code bases her views, along with those of other philosophers, in expressing how ecological thinking is 'about imagining, crafting, articulating, and endeavoring to enact principles of ideal cohabitation' (Code, 2006, p. 24). Her position mirrors my own proposal of finding a 'symbiotic way to design.'

Intentionality also relates to the theory of 'Purposive action' (Maxwell, 2014, p. 122). We humans, as purposive beings, act in the world in the pursuit of our own goals but now, in the 21st century, we are entering a stage of awareness of our human intentions, where every new technology and its interactions with a more-than-human world reverberates throughout the web of life. Our latest invention, the Internet, is giving us the communicative power to visualize this interconnectedness and to realize how fragile, dangerous and creative we are as a species.

Creativity is ultimate. It is not a philosophical position but an observed fact that can be considered by design as a formative process, an intrinsic property of anything in the natural cosmos that is known to us. Goldsmith (1996, p. 182) asserts that 'the creativity of the living world is only a problem if we insist on trying to reconcile it with the paradigm of science. It is totally reconcilable, on the other hand, with – and is indeed an essential feature of – the world-view of ecology.'

According to Victor Papanek, in his highly criticized book, *The Green Imperative*, designers are a dangerous breed (Papanek, 1995). As intended, this statement resurrected key ethical questions for design practitioners and teachers to rethink not only their creative ontology, but also their intention – framing new ethical paths for the design guild. From this, we are better able to establish a new curricula, schemes and policies to activate a strong relationship with our planet. For example, from minimalism styles, slow food movements, the use of 3R's (reduce, reuse, recycle) and other related trends, pedagogical efforts have arisen to improve the planetary intention. These have started to attract interest mainly because of collective efforts and the convergence of

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[5] See glossary: How an ecomind thinks, by Lappe (2013).

several interrelated fields such as environmental sustainability, landscape architecture and permaculture practice, which have begun to work on the convictions of the design academy and beyond.

Many ecological thinkers have been expressing similar ideas. For instance, Gunther Altner points out that: 'The prime obligation of human beings toward their fellow creatures, is not the derivation of self-awareness or sensitivity to pain or any special human achievement, but the knowledge of the goodness of all creation, which communicates itself through the process of creation. In short, nature imposes values because it is creation' (Goodwin, 1997, pp. 215–217). Altner identifies several considerations that are relevant to this research thesis:

- The rapid dynamic of human history is threatening to tear apart the indispensable ties that bind us to the history of nature, which runs more slowly. For this reason, moratoria (pauses of thought) are indispensable so that we can examine the unforeseeable consequences of science, technology and progress.
- The possibilities of intervention provided by modern biotechnology, especially genetic technology and the biology of procreation. Interference with heredity and the reprogramming which that produces is extremely problematic.
- The rights of nature must be shaped in such a way that nature is taken seriously as a 'third partner' in business alongside economic factors.

Such moratoria could be regulated by the way we teach designers to create for the world we are participants in, by undertaking a critical inquiry of symbiosis. Learning from nature without giving anything back is not symbiosis. Manipulating, without measuring, consequences will bring problems to the way we might create naturally inspired design and engage a 'rights of nature' (Goodwin, 1997, p. 218). Regarding these 'rights of nature,' we can readily identify the following morals that designers cannot simply take for granted:

1. Nature – animate or inanimate – has a right to existence.
2. Nature has a right to the protection of its ecosystems and of the network of species and populations.

3. Animate nature has a right to the preservation and development of its genetic inheritance.

4. Living beings have the right to live in accordance with their species, including procreation, in the ecosystem appropriate to them.

5. Interventions in nature need to be justified.

All these points are then a manifestation of a constant need to review our ways of designing and thinking, ecologically.

These kinds of ecological approaches and definitions are helping to restrain the technocentric and managerial aspects of our current human systems. As we begin to awaken and redesign our society, we have also begun to display new ecopedagogies to better understand the potential of ecological design.

1.2 On design education for the 21st century: From knowledge to wisdom

For most of us, the human knowledge has reached outstanding levels of literacy. However, a continued friction between the arts, humanities and the sciences has affected the way we educate for a sustainable future. On one side, the humanities deal mainly with ethical and economical dimensions and, on the other, the sciences pursue the explanation of phenomena that then leads to the creation of new technologies. This has created a fragmentation of specializations and sub-disciplines based on old paradigm thinking which then continues to concentrate on the alleviation of the constraints of the past decisions and their continued influence on present intentions and plans for human culture.

The design academy, with its potential to interrelate the arts and sciences, needs to recognize that not only do we have to teach the students how to solve the problems of living but also how to articulate solutions, not only by changing the way we think about new possible products or services, but to question holistically the purpose and attractiveness of those designs for planetary life. These kinds of ethical and aesthetic dimensions will encourage us to embrace alternative pedagogies.

For Yagou (2014), design pedagogy, or design education, is defined as 'the set of practices and systems for the training in the field of design; the ways and methods of teaching for the acquisition of necessary knowledge and skills in order to practice the design profession'. This definition implies that we need to go beyond "just" necessary knowledge and to recognise individual and collective wisdom. Contemporarily, wisdom can be defined as:

> *'a virtue that is a habit or disposition to perform the action with the highest degree of adequacy under any given circumstance. This implies a possession of knowledge or the seeking thereof in order to apply it to the given circumstance. This involves an understanding of people, things, events, situations, and the willingness as well as the ability to apply perception, judgement, and action in keeping with the understanding of what is the optimal course of action. It often requires control of one's emotional reactions (the*

"passions") so that the universal principle of reason prevails to determine one's action. In short, wisdom is a disposition to find the truth coupled with an optimum judgement as to what actions should be taken in order to deliver the correct outcome (Blanshard, 1967).

From this definition, we can raise the following question: Is the design academy implementing the virtue of wisdom in its pedagogy? Ecological philosopher Arne Naess describes the necessity of establishing a different kind of educational system that involves a deeper and freer way of developing wisdom:

...We need an educational system that explicitly takes more account of the emotions. We talk about education, a word derived from a Latin verb meaning "to lead forth." I say that we ought also to talk about the opposite, what I might call 'inducation,' that is, the nurturing of innate values like wonder, creativity and imagination. There are many subjects that are well adapted to promoting such qualities, but we must produce teachers who are allowed to be personal and given more freedom in the way they teach. Furthermore, the standards of attainment must be lowered – to learn well is to learn slowly. Teaching is only effective if pupils and students concentrate now and then on something for which they have a burning interest. (Næss and Haukeland, 2008)

As we find ourselves in constant danger of becoming unfamiliar with our human values, insight and wisdom, we require interventions such as perennial philosophy in design education which sees 'how the interiority of Nature and the interiority of the human being coincide and manifest through creation' (Naydler, 2013). Seeing the aesthetics, truth and goodness that nature offers may be the basis for the philosophyof good design that we may need to pursue in the design academy[6].

We may believe that objective scientific methods are the causes of our current global problems (Maxwell, 2014), as science pursues its own brand of knowledge through our academic disciplines, but we can also see its weaknesses when wisdom becomes the inquiry. A wisdom inquiry holds a methodology for all forms of inquiry, including problem-solving rationality and aim-oriented rationality (ibid, p. 55). Thus, ecological thinking, when embraced by the design academy, must accept not only to solve problems of living, but also to articulate solutions holistically if design is to adopt the premise of the wisdom-inquiry.

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[6] Philosophy, in one of its functions, 'is the critic of cosmologies. It is its function to harmonize, refashion, and justify divergent intuitions as to the nature of things. It has to insist on the scrutiny of the ultimate ideas, and on the retention of the whole of the evidence in shaping or cosmological scheme' (Whitehead, 2011).

Problems of living are not solved with just good science – e.g. improving a new material – or with art, which only enhances individual expression. What is required is the balance in between and that is what design should offer. For example, some design teachings promote innovation through the logic of creating new inventions, whereas it might be better teaching ways to see the problems from different perspectives or how to reflect on basic needs, before producing a design. New design pedagogies may need to be framed to criticize or re-interpret these problems that reach planetary well-being.

Design can bring value to our humanness, but there is also a need to unmask false values. Maxwell (ibid, p.39) claims that what we need from wisdom is an 'interplay of skeptical rationality and emotion'. Therefore, from the sciences and the rigidity of quantitative methods, to the intuitive flexibility of the qualitative methods from the arts, the design disciplines may help the academy to build a structure of new pedagogies. Currently in some of the design disciplines, the themes of ecology and sustainability are embraced to encourage an entrepreneurship that is willing to *know how* to incorporate these concepts. However, we also need to train entrepreneurs to *sense how* to develop those concepts.

Since the beginning of the 21st century, it seems that science has been improving 'our knowledge' about Nature and has been giving us new and astonishing technologies. The challenge now is to bring new methods outside sciences that get to the roots of ecological philosophy (or ecosophy). This meta-level of understanding raises the need to incorporate a mix of unconventional methods and well-known methods[7] in our practices. Employing empirical methods from the natural sciences, together with qualitative methods promoted by the arts, can provide an active role for new education schemes. Feelings and desires, moral values, ideals, political and religious views, expressions of hope and fear, can be mixed with the observations of truth from being part of nature and can help us to tackle design problems through the notion of 'ecological wisdom'. Going into the areas of phenomenology and the study of ecoliteracy in design education will

[7] In this research, we can describe it as meta-methods – a mix of scientific and artistic methods – aimed to deal with the complex idea of symbiosis. This will be displayed in Chapter 2.

constitute new areas to be explored.

As we begin to ask questions of why things happen and how things happen, we realize that ecological thinking is 'teleological' (Goldsmith, 1996, p. 29). In an ecological worldview, the sciences and the arts are reinterpreted as in design. Albert Einstein reputedly said, 'We cannot solve our problems with the same thinking we used when we created them'. This statement suggests that we can test ecological thought and its authority against the conventional ways of designing and our abilities to acknowledge wisdom itself. We might argue that current design pedagogy continues to promote the resolution of design problems from within the same perspective, thereby encouraging the designer to design 'inanimate things', instead of helping the designer to design 'animate things' for a living planet.

In order to provide an appropriate context and to expand on the notion of wisdom in design, it is necessary to briefly explore the meaning of knowledge. Knowledge is defined as 'learning to probe questions and creating the answers'. Knowledge is differentiated from intelligence (ability enhanced by training to manipulate information) and from information (objective body of conceptual and relational items). Knowledge relies in part on both intelligence and information 'but in a systemized and organized way' (*Encyclopedia of Creativity*, 2011, p. 120). Problems with clear, agreed upon solution strategies and specific answers are considered 'well-defined problems' (*Encyclopedia of Creativity.*, 2011, p. 122 vol 2). In this context, scrutinized design problems generate wisdom, and by framing them correctly, the design solutions generate life-affirming decisions, not just knowledge.

Decision making lies at the heart of wisdom (Hall, 2011, p. 7). This latter affirmation leads to questioning the design ontology. Making decisions about what to design or what not to design draws on our emotional, intellectual and collective way of life. The accumulation of knowledge and one's experience of thinking about what is good now and the effect in the future also relates to generating wisdom. According to Hall (ibid), the meaning of wisdom is to 'converge in recurrent and common elements: humility, patience, and a clear-eyed dispassionate view of human nature [...] and an almost philosophical acknowledgment of ambiguity and the limitations of knowledge [...] nettled in contradictions, wisdom is shaped by uncertainty. Action is important, but so is judicious inaction' (ibid. p. 11). Hall also adds that wisdom is seeing differently in order to reframe situations (ibid, p. 17). Taking this point of view itno account, we can conclude that wisdom is a way to reframe the ontology of conventional designing by questioning it. This can lead to enhancing our pedagogies and, most importantly, re-expressing our relationship with life on Earth.

It is now clear that wisdom is becoming an important issue for education in the 21st century. Because there is a lack of wisdom in society, this does not mean that we need to teach people to be wise; rather, we need to help people to be wise in their own way and *within the living world*. This means that we need to teach the students to care for their own creative potential with the more-than-human world.

Making sense of the world requires us to activate wisdom, or as Huggins says: 'inactive wisdom is like bread that failed to rise' (Huggins, 2013). From this perspective, design education needs to accomplish a "right" action now and needs to activate our *ecological wisdom*. By igniting it, we are more able not only to design artifacts that make sense but that also 'make sense for our planet'. The aim of developing this approach of ecological wisdom through design education is to learn to experience how the world works and to feel the 'life-intention' in every design. Such a life-intention, is to learn to act consciously and collectively along with our eco-others. This kind of wisdom is not an imperative as it is supported by ecological philosophy, which transcends the structured ways of education.

Stimulating the imagination or stirring self-realization growth goes beyond educational schemes. As we live life, we find ways to learn new things and to rediscover our inner wisdom. The acquisition of wisdom is related to a variety of factors: general intelligence and education, early exposure to meaningful mentors, cultural influences, and a life of long accumulation of experience (Hall, 2011, p. 216). Hall identifies how the development of wisdom 'counsels a goodness that extends beyond the membrane of ego and our self-interest, and radiates outward in an enveloping generative energy that empowers loved ones, kin, students or various tribes of affiliation. It gives us a chance to perform the magic of being simultaneously selfless and self-improved' (ibid, p. 270). The idea of the 'common good' is also one of the features of wisdom (Hall, 2011, p. 245). Within all of these features, the aim it is to find a balance between the intrapersonal, interpersonal and extrapersonal.

Cultivating wisdom is critical for the future of our civilization. Stenberg argues that 'we have constructed an educational system to produce people with skills to lead us in exactly the way 'we don't want to go', and he concludes that if the education system is aimed at valuing wisdom, it will be a kind of Socratic approach which embraces the following:

- How to use the show-rather-than-tell approach to balance and competing interest in everyday decision-making tasks,
- How to incorporate one's moral and ethical values into ones' thought processes,
- How to think dialogically (other-centred approach to understand multiple viewpoints)
- How to think dialectically (to understand a solution that is right at one time and places may be wrong when circumstances change) and,
- How to become self-conscious in a positive and enlightening way, monitoring one's thought processes and decisions through a lens of wisdom.

Stenberg's approach acknowledges how teachers will help the students to take a more active role in constructing their learning. He concludes that 'in the end, wisdom is the only thing that will save us' (cited in Hall, 2011, pp. 246–247).

One of the critical aspects of developing wisdom through ecology is the application of 'self-realization', an approach of 'being in the world' (Naess, 2010, pp. 81–96). From this standpoint, the ecological self needs to identify and express love for being in the world and the self-interest of such a force (realizing inherent potentialities). In this case, designing for the living world will imply a reformulation of an internal relationship with our creative spirit and an external relationship with the creative spirit of the cosmos. Designing is a beautiful act, it is what *naturally* needs to be. Feeling happy in the way we design and live is perhaps what we are looking for.This self-realization embodies wisdom. Being mindful of our creative spirit *with-in* the Earth embodies ecological wisdom.

This dynamic ecological model (See Figure 1) is a way to interpret ecological wisdom. The blue cloud represents the conventional knowledge immersed within a yellow cloud of the unconventional wisdom, but only when this is acknowledged does it turn green as a reflection of self-realization of ecological wisdom. This type of life-mutating cloud, is a 'natural way', and an eco-philosophical way of designing.[8]

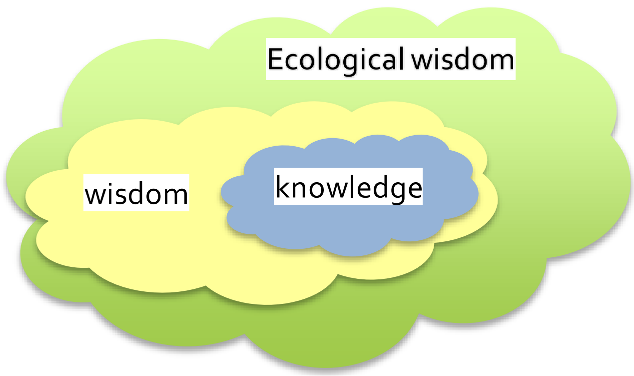

Figure 1.Ecological Wisdom
This nested cloud in which knowledge expands to wisdom and wisdom expands to ecological wisdom under appropriate circumstances

As we approach a meta-methodology or a metadesign method in the following sections, we need to also consider the concept of meta-wisdom which, in the words of Hall (2011, p. 205), means 'an invitation to reframe to step back and reassess a vexing situation from top to bottom [...] it means to deliberate'. It is used to break the habit of shallow anthropocentric efforts and the shallow design tradition that exist without ecological thoughts. With an *ecological wisdom* inquiry, it is more likely that educational institutions will be better prepared and open to all aspects of cooperative understanding, and to incorporating alternative disciplines and radical thinking as a positive input in reconciling our relationship with Nature; this is meta-wisdom.

[8] The swirling model of ecological wisdom can help to model a natural way of thinking, mentoring or becoming. Different shades or lines of color could be identified as different types of knowledge, which might require further research.

To achieve this, we need to introduce not only ecological theory but also practices that can help the individual to 'experience the world'. Pedagogical strategies, such as meditation or outdoor activities, can play a critical role in experiencing the whole and the self, enhancing creativity and ethical response (to be discussed in Chapter 3). A strong *design eco-pedagogy* is one that enlivens the self and the ways we create.

In this converging crisis – social, ecological and intellectual – an alternative outcome is to educate people to become not just specialists but holistic designers. The time for universal planetary consciousness in all disciplines, including design, is now. Universities will continue to be a bridge for universal knowledge, but they will also need to enhance our ecological wisdom. Helping the design academy to implement such an ecological wisdom strategy through this research is to propose a vital, feasible and innovative inquiry.

Can we find wisdom through designing symbiotically? This is one of the inquiries that will be addressed in the following chapters. The question is not how the design academy can implement this virtuous wisdom but how the design academy can teach students how to become wise, not only by making conditions conducive to life, but how to symbiotically create such conditions. For example, instead of just teaching students how to produce and market products, the design academy could teach them how a product needs to be shared and how to embrace a more-than-human world.

Acknowledging our limitations of feeling separate from Nature can also be called ecological wisdom. This somewhat philosophical foundation sets the epistemological and ontological context of a ***Symbiotic Design Practice (SDP).*** Our human arrogance and ignorance may be dissolved by sensing, engaging, acting with and becoming one with nature.

1.2.1 The Importance of Ecological Literacy and Ecopedagogy in Design

There is a need for an integrated worldview in the future of education. This need to relate to the living unity of the world focuses on getting back to the vision that has been lost as Fideler (2015) inquires:

> *Where is the Life we have lost in living?*
> *Where is the wisdom we have lost in knowledge?*
> *Where is the knowledge we have lost in information?*

Fideler discusses that the greatest need for a functioning worldview is born out of the fragmentation of knowledge by academia. We have been very good at taking the world apart and, consequently, we have created specialists who are ill equipped to think in terms of whole systems. Fideler outlines a contemplation of the future of education, deducing that:

> *'if the educational system begins to fail us in specific ways then there will arise a clear invitation to once again consider the spirit of the humanities, the liberal arts, our underlying philosophies of education, and the historical roots of our traditions'.*

In transcending these educational barriers, the design academia must not limit its concerns to the individual as design influencers, but rather it needs to include the diversity of society's worldviews on how they experience nature's designs.

New courses and professional profiles are beginning to be integrated into the design academy (i.e. digital interaction design or design and marketing). Accordingly, this academic growth also needs to contain, and so awaken, the ecological literacy of the student. Orr (2004a, p. 31) points out that conventional education is diluted in the false and distractive information that our current technopoly embeds. For this reason, alternative pedagogies in education are needed to question the effects of digitalization, urban sprawl, global corporations and non-stop advertising that promote dominance, power, speed, accumulation and self-indulgent individualism.

Designers ought to be trained to assess their own power to facilitate the tools, messages and environments which improve the quality of life. The question is 'What kind of ecoliteracy is provided in the design academy?' If design for the living world is to design with the Earth in mind, with the parts and the whole, it is this meta-level of ecological literacy that needs to be promoted in design. This is an important philosophical position for the design pedagogy, because incorporating this kind of teaching shows the way to understanding human intent for the living world, and not only to show the way to express free will. This means moving from shallow design creationism to active wisdom in every idea that the design student conceives. Is the current design curriculum providing the tools for self-understanding, meaningful design and planetary ethics?

Contextualizing ecological design and its pedagogical position to tackle this problem would be a real active input of *ecoliteracy*. Capra (2002, p. 201) describes this concept as follows:

> *'the first step in our endeavor to build sustainable communities must be to become ecologically literate i.e. to understand the principles of organization, common to all living systems, that ecosystems have evolved to sustain the web of life'*.

A central feature of ecological literacy is the reconnection and understanding of living systems, in the form of a 'connected wisdom' (Sweeney, 2009). This kind of ecological intelligence 'is about being collaborative [...] to understand how nature sustains life' (Goleman et al., 2012, pp. 1–17). It is also about recognizing in our ecological selves the expression of living organisms, from forest to mountains, and our ways of organizing our society in the image of other living systems. An ecoliterate designer will then be following life's patterns. In this thesis, biomimicry, biophilic design and resilient strategies can be considered key concepts to develop.

The notion of *designing with-in our living planet* is based on the recognition that our planet has intelligence and intention and that we are wise enough to find out what it can teach us. The ecological wisdom inquiry embodies this metadesign notion and leads to the understanding that we need to learn not only to become designers but also to be true Earthlings. Being educated in this way is to fully appreciate the *purpose of being human in* *the living world and to recognize the living world as purposeful for all life forms, including us.* This affirmation emphasizes the question of what it actually means to be ecoliterate.

Bringing ecological literacy into the arena of design might help to expose the problem of the lack of wisdom in the context of the design pedagogy. Clearly, unwise designing is likely to contribute to the creation of an unwise society. This research arises not only with the intention of helping to save us from an ecocide and providing a resource to design with-in nature, but also as an action to help us ignite wisdom in future ecological designers and design educators.

Some of the inquiries related to design education arising in the context of this research are as follows:

- What kind of educational methodologies can contribute to ecological solutions and at the same time articulate new design epistemologies? (Ecopedagogy)
- How do we integrate design in everyday practice and thinking at the planetary level? (Ecosophy)
- How can we achieve greater civic involvement with our planet through design? (Ecoliteracy)

Pioneers like EF. Schumacher suggested that education is 'our greatest resource but also warned that unless it clarified our central convictions it would ultimately be a destructive force' (cited in Sterling, 2001, p. 12). In this context, education is aimed at constantly reconfiguring our worldview. An ecological pedagogy challenges our current educational systems aiming to be 'transformed and transcended' (ibid, p. 20).It is a failure to educate people to think broadly, to perceive systems and patterns and to live as 'whole persons' (Orr, 2004b, p. 2). These arguments suggest how ecopedagogy can be considered a meta-context in design education.

Teaching design often implies a classroom-style approach where theory and methods are concepts that are important to learn. However, because it also integrates a workshop-making approach, experience and practice – through prototyping for example – both become part and parcel of design pedagogy. This form of experiential learning is one of the advantages of the design discipline. Ausubel (2013, p. 189) expresses how a curriculum is any place where learning happens, and also how education is about learning to live in this interdependent world. One of the most important things is the 'sense of wonder' (Carson, 1998). This means bringing a lived experience into our lives, to be immersed in, to interact with and to provide an early validation. This allows us to encounter and be closer to our true Nature and will encourage us to fall in love with the world.

As already discussed, learning from the natural world is fundamental for the development of wisdom. Through ecopedagogy, we will realize how the inputs to our creativity, morality and consciousness – as eco-psychological features – cannot be developed without the integral learning that nature provides (Roszak, 2001).The ecopedagogical aspect needs to be, if not at the core, one of the main strands of design education. This situation has been improving in recent years. Centres of sustainable development, eco-design, alternative technologies and ecological transformation have been working toward the transition to naturally inspired pedagogies.[9]

Ecopedagogy as a movement is promoting a radical transformation in our society and the design academy is no exception. Such a movement is reaching to the very roots of the design pedagogy, and that is why this research is so relevant at this moment[10]. Kahn (2010) reflects on how several early authors, especially Paulo Freire, have dealt with this notion. His approach to 'critical pedagogy' and 'eco-humanism' conceives of the need to 'dialectically overcome the objectification of human and non-human natures as part of a more fully inclusive vision of liberation' (ibid, p. 21). He also explains how ecopedagogy is neither a 'strict doctrine nor a methodological technique that can be applied similarly in all places, at all times, by all peoples'. These facts must then be applied mindfully to the politics of the design academies that want to make the difference. Reinterpreting and restructuring the context of design education then relies on the ecological thinking and the holistic curriculum strategies.

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[9] Some examples: https://www.schumachercollege.org.uk, http://www.cat.org.uk, http://www.ecoliteracy.org

[10] See glossary: Contributions of the Ecopedagogy Movement

In the traditional way of pedagogy, the separation is inevitable between school, families, subjects and religion. In the ecopedagogical way of approaching education, all the aims are integrated. Educators such as David Orr (2004a), Herbert Marcuse (cited Kahn, 2010) and John Miller (2007) offer standpoints in which education needs to go beyond the college into everyday life, where our bodies, imagination, intuition and related mindful practices are part of non-standardized ecoliteracy structures.

For example, Miller (2007, p.5) insists that we need to build a holistic curriculum which is intended to 'put our life and our institutions more in harmony with the ways things are. If nature is dynamic and interconnected and our education system is static and fragmented, then we only promote alienation and suffering. But if we can align the institutions with this interconnection and dynamic, then the possibilities for human fulfillment increase greatly'. In this way, the need of transmission (curriculum to student), transaction (curriculum to student, student to curriculum) and transformation (a symbiotic way of learning) is viewed as holistic. Miller differentiates holistic education as one in which relationships between people and things help to find a balance of inclusion and connection (ibid. pp. 13–14). Some of its features involve the following integrations:

- 'Linear thinking and intuition. To find a balance using metaphor and visualization to integrate traditional thinking approaches.
- Between mind and body. To sense the connection between the two. Movement, dance and drama can be explored.
- Among domains of knowledge. To connect academic disciplines and school subjects. E.g. Waldorf schools using the arts to learn about the world.
- Between self and community. To go from the classroom to the global community. The student must develop interpersonal, community service and social action skills.
- Relationship with the Earth. To listen the voice of the Earth; sounds of animals, wind and rippling streams can connect us with the web of life.
- With the self and soul. The holistic curriculum lets us realize our deeper sense of self, our soul. Our true nature'.

As the holistic curriculum helps one find the inner self and the mysterious unity with the cosmos, it instigates the development of wisdom and the cultivation of things such as intuition through contemplative practices and social action. Miller also uses Ken Wilber's integral approach (Wilber, 2008). In Integral Theory, the four quadrants describe four aspects of the human being: the interior (I) and the exterior (it), which is then sub-divided into the individual (its) and the collective (we). A holistic curriculum involves whole systems thinking which extends, connects and integrates three aspects of the paradigm: 1. the normative aspect (ethos) which affirms beliefs and courses of action; 2. a descriptive aspect (eidos) which is how we conceive of the world; and 3. a practice aspect (praxis) which represents manifestation in action (Sterling, 2001, p. 49). Sterling suggests a three-part model that identifies the ecopedagogical aspects that sustainable education should integrate. He concludes that this kind of educational model of learning would be 'intrinsically transformational in itself, and its community members promoting systemic coherence'. The model's features are:

- Extended: Appreciative, Ethical, Innovative, Holistic, Epistemic, Future Oriented, Purposeful
- Connective: Contextual, Re-focused, Critical, Systemic, Relational, Pluralistic, and Multi and Transdisciplinary
- Integrative: Process Oriented, Balancing, Inclusive, Synergetic, Open and Inquiring, Diverse, a Learning Community, Self-organizing.

Finally, and briefly, the last aspect to be highlighted in ecopedagogy is the understanding of the 'pattern that connects' (Bateson, 2002), in order to make interconnections that allow systemic coherence with human intention as a nurturing healthy act.

In this way, ecoliteracy can help us to dilute cleverness and acquire wisdom or 'true intelligence', as Orr (cited in Sterling, 2001, p. 8) calls it. He explains how authentic learning 'engages, induces, encourages and enthuses[...] into being a whole person who is capable of thinking critically and living with compassion, energy and high purpose' (ibid). Such a shift in the education paradigm can be seized by the design epistemology.

By incorporating these ecopedagogical virtues in the design academy, the transformational self-realization of the student within our communities will become imminent.

To build on the argument of ecopedagogy in design, it is necessary to reconsider pedagogy itself. The *paideia* emerges from the ideology of agriculture, where early uses of the concept of education and cultivation were as likely to refer to the upbringing of plants or non-human animals as they were to the rearing of human children. Furthermore, the Hellenistic *humanitas* became the force of 'civilizing' which then led to the Enlightenment (Kahn, 2010, pp. 48–53). It was in this age of reconciliation – within human culture and nature – that the ecological thought begins to *enliven* our actions (Weber, 2013). Within this definitions, a design ecopedagogy could then be expressed as 'the practice of training holistic minds that question the role of design and consider the well-being of a more-than-human world'.

The renowned *Centre for Ecoliteracy* includes in its foundation courses the involvement of teachers and students' achievements of ecological well-being through hands-on, experiential and contextual learning. The Centre has developed a set of principles for becoming ecoliterate by learning the how (head), learning to be (heart), learning to do (hands) and learning to be together (spirit)[11]. The Centre also pursues the following five ecoliterate practices that allow students to strengthen and extend their capacity to live sustainably (Center for Ecoliteracy, 2015): 1) Developing Empathy for All Forms of Life, 2) Embracing Sustainability as a Community Practice, 3) Making the Invisible Visible, 4) Anticipating Unintended Consequences and 5) Understanding How Nature Sustains Life.[12]

With this set of principles, we can see how 'Developing Empathy for All Forms of Life' relates to the concept of *biophilia*; 'Making the Invisible Visible' relates to the concept of *biomimicry* as it is implicit in what we create; 'Anticipating Unintended Consequences'

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[11] See glossary: Principles of ecoliteracy
[12] See glossary: Five ecoliteracy practices

links with the concept of *resilience*, as we practice a sense of cautiousness; and finally, 'Understanding How Nature Sustains Life' relates to the *symbiotic ways of life.*[13]

This last example questions whether the design academy is interested in the further development of the ecological pedagogy with questions such as: How can we educate designers to become aware of their creative intentions? Are we designing to create a meaninful understanding of a more-than-human world? Such deep ecological questions denote that design disciplines need to be open to alternative deeper ways of thinking, a shifting paradigm in the enlivenment times.

As we can see, ecoliteracy, and especially ecopedagogy in design, are pathways that can help to create a philosophy of doing with meaning and the embracing of nature's teachings in order to act in the real world. This means that we need to educate to such a symbiotic worldview. This may be the real intellectual and cultural challenge of our times in order to deliver education in the 21st century.

1.2.2 Deep ecology and its value for a new design education

The way in which designing with-in nature needs to be taught should be based on the principles of deep ecology, which emphasizes the 'intrinsic worth of all beings and treasures all forms of biological and cultural diversity' (Naess, 2010, pp. 27–28). The way our creative-self shows love for creating the conditions conducive to life lies in a genuine identification of what the designer wants to become. This self-interest in learning from nature is a virtue that the design academy must develop through its curricula. Such ecopedagogy involves questioning every purpose as planetary beings.

We have an intuitive and deeply rooted attraction to nature. This biologically inherent need endorses the essence of deep ecological thinking which will help to establish a

[13] All these concepts are further explained and developed in the SDP in Chapter 2

relationship with a more-than-human world[14]. Indeed, positioning deep ecology into practice can embrace its ethics and enhance our way to appropriate innovation.

Establishing a deep ecological pedagogy within the domain of design education does not involve any predetermined goals other than understanding the value of human design. Designing requires profound thought, common sense and an ethical posture. We are saturated with a particular kind of ethics that is pathological, and largely unconscious (Curry, 2011, p. 10). Curry affirms that nature is the ultimate source of all value and it is what ultimately determines our ethics. In the case of design, ethics is not an exact statement of being right or wrong; it is more a way of questioning our source of inspiration, the biological roots of our education in design and how we practice in the world.

To improve the world through design, we need to be mindful of when to act and when to leave nature to take its own course, and how to design to her rhythms. The following poem of Lao Tzu captures the essence of the need to be open to learn from nature's way:

Do you think you can take the world and improve it?
I do not think it can be done.
The world is sacred.
You cannot improve it.
If you try to change it, you will ruin it.
If you try to help it, you will lose it.

Like it or not, planetary ethics are embedded in every design. By adopting an ecological ethic through design, we are able to criticise not only design solutions, but also the ways of institutions and their pedagogies. Every planned strategy should, therefore, transcend the ethical dimension toward a peaceful planetary evolution. Cooperative agreements with nature, sharing nature's lessons, defining co-evolutionary models and other reciprocal altruistic examples can all be taught in design.

Designing with-in nature is seeing how our creativity pleases life. To see ourselves 'alive and infused with purpose', 'aglow with seductive sensuous qualities', and 'not an

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[14] See glossary: Arne Naess' deep ecological premises.

alienated observer' (Goldsmith, 1996, p. 145) is a deep ecological response. The deep ecological worldview manifests a Gaian Hierarchy. Such purposeful hierarchy in the living world 'can be identified with the tendency of living things to maintain the whole' (ibid, p. 150). In this case, the design ontology becomes purposely fulfilling, metabolizing and attuned with the self-regulating patterns of Gaia, where all objects and actions are symbiotic.

A re-enchantment of human wisdom, mentored by Nature's genius, may help us to navigate toward deeper levels of consciousness. Redefining planetary ethics, where our hearts, minds and bodies respond to the Earth's rhythms and requests will surely guide us toward good design. Design educators should then help to redefine a design education that resonates toward the transformation of our human culture. As deep ecology touches ethical and metaphysical preoccupations (ibid, p. 443), it can help us to make the transition to an ecologically driven civilization. This precise form of inquiry into becoming an eco-civilization (as will be discussed in the following sections) is where ecological design is heading.

We have transcended the Age of Enlightenment, where science provoked a rational ordering of human affairs, to a liberated Age of 'Enlivenment' (Weber, 2013) where the sciences and the arts interrelate to give better answers about human intentions. This change of era is not only prompting new moral behaviors, but also collective planetary ethics. We look to nature for answers, but also for help to structure our questions about such an ethic (Riechmann, 2006).

In the Age of Enlightenment, the power to manipulate the natural world and to separate mind and body brought technological intentions, many of which damaged the natural world. As we transcend the Age of post-Enlightenment through ecological design, it appears that our arrogance is decreasing. A mutual emancipation is happening, through the Age of Enlivenment. It is moving from the shallow ecology of the Enlightenment to the deep ecology of the Enlivenment. Here, anthropocentrism dissolves or is acknowledged at a different level. We see our design powers as gifts that need to be deeply rooted in empathy, kindness, humbleness and a modesty that life itself inspires. Moreover, we seek to take into account the intrinsic symbiotic relationship between humans and nature.

We are bringing the mastery of nature to the ecocentric level, where the scientific (theory), technological (material) and ethical (praxis) masteries are intrinsically interrelated. Hayward (1995, p. 23) points out that ecological thought is 'opposed to enlightenment rationality and values in these ways: its methods and epistemology are not reductionist, its ontology is not dualistic, and its ethics are not atomistic. In each respect, ecological thought is *holistic.*' Ecology is the centre of a new paradigm in contemporary thought where it can be very scientific or radically teleological.[15] Life-inspired design is enhancing our cultural response by helping to re-craft new artefacts, buildings, scientific theories and institutions.

Our capacitiy to mindfully design with the patterns of natue are disjointed. Orr (2004a, p. 31) points out that 'the ultimate object of ecological design is not the things we make but rather the human mind and specifically its capacity for wonder and appreciation'. He also suggests that given our inability to satisfy our primal needs, we suffer a *deprivation of ecstasy*:

> *'...the 99% of our lives as a species spent fully engaged with nature. Having cut ourselves off from the cycles of nature, we may find ourselves strangers in an alien world of our own making. Our response has been to create distractions and addictive behaviours as junk food substitutes for the totality of body-spirit-mind nourishment we've lost and then to vigorously deny what we've done.'* (ibid)

From these postulations by Orr, we can identify how mute our sense of wonder and our sense of ecstasy are as we direct our attention to our egocentric humanity, not our ecocentric sensuous self. Recognizing the desire to design for a living world will play an important role in forming the new profile of the ecological designer for the 21st century.

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[15] See glossary: Roots of *Ecology*.

We need to consider how nature is constantly informing us how to design. To do so, we need to stimulate a sense of learning from all living things. This kind of vocation exists in all of us. If we are to move to a truly sustainable future, then all designers will need to be familiar, not only with *designing with nature* (McHarg, 1996), but *with-in Nature,* as here suggested and to be expanded on in chapter 6.

As we open up to learning from nature and design with nature, with such a realization, we can begin to acquire new knowledge. As Ivan Illich (in Goldsmith, 1996, p. 336) points out, 'most learning is not the result of instruction but rather the result of unhampered participation in a meaningful setting'. This "meaningful setting" is our living Earth, and ultimately it is what inspires us to design.

Naturalism is something that is still a major barrier to our contemporary understanding of ecology. In the 17th century, the science of biology adopted an approach that influenced naturalism. Its modus operandi from physics questioned the how and not the why, thereby removing the esoteric and, therefore, becoming more technical. Language, consciousness, awe and emotion with respect to natural phenomena as perceived by ancient traditions were excluded, and knowledge became 'deterministic and hierarchical' (Sessions, 1995, pp. 137–139). Now, the ceremony, relevant mythical cosmogony and artefacts of the original *cultus* of knowing about nature, are only found in museums and rarely in our everyday lives. The need to bring alive a new form of naturalism is imminent and design can play an influential role.

We have already started to probe some of these hidden secrets by mimicking the ways of living of plants, animals and (or) bacteria. Their behavior, organization, communication and use of materials are now beginning to be understood and applied in high technological crafts, such as 3D printing or for military purposes like self-organized drones, to the most vernacular of crafts associated with our essential needs like local food production. The patterns and languages of nature that were deeply studied by the art and design disciplines of the past might now be strengthened by the new ways of naturalism. This neo-naturalism might help to consolidate the new epistemology of design.

If we look at the history of ecology and biology, we will find that these sciences have their roots framed in the particular way that we, as humans, began to study plants and animals. We began to draw, categorize, catalogue and question the dynamics of the patterns and organization only to finally arrive at the conclusion that we are *intrinsically interrelated*. When Ernst Haeckel defined *ecology* in 1866, his work aimed to study morphology by identifying interactions and structures between given places and time. This is now treated as a holistic science (Borden and Collins, 2014, pp. 40–70). The notion of natural history also opens up opportunities and methods of inquiry into neo-naturalism or Enlivenment. The reality is that we are beginning to identify the collective efforts and transdisciplinary ways of working with such a 'naturalistic lens', from regeneration to rewilding, biomimicry to synthetic biology, biophilia to indigenous wisdom, and other related concepts that will be discussed in later chapters.

1.3 Building the foundations for a new design ecopedagogy

In subsequent chapters, this research will embrace four concepts, here described as ecological techniques or 'eco-techniques'. These include biophilia, biomimicry, resilience and symbiosis. These have been studied to improve ecopedagogical schemes, which still tend to be neglected in the design disciplines. To solve this problem, old and new eco-techniques are needed where biophilic, biomimetic, resilient and ultimately symbiotic minds are able to reconcile nature-culture reciprocity, shifting our design practice from human-centred to planet-centred practice.

To give an overview of what *eco-techniques* mean, we need to explore the etymological roots of the word *Tekné*, meaning 'an art or skill to perform a task'. One of the better definitions, in terms of design, is that put forth by Bruzina (cited in Ingold, 2011, p. 294), who defined *Techne* as 'a general ability to make things intelligently', an ability that depends upon the craftsman's or artisan's capacity to envision particular forms, and to bring his manual skills and perceptual acuity into the service of their implementation. Techne 'produces and creates from the senses and intuition' (Erikson, 1991, p. 164).

A technique then questions thinking and making at the same time. If we add this to the precept of *ecological,* we can find an immediate relationship to ethically question the intention of technology. Technology is a way to question our philosophy of making, and has its roots in *technique*. The problem lies in the way we perceive it in a contemporary context. In a way, eco-techniques or eco-technologies are the alternative form to keep us feeling part of a more-than-human planet.

Practicing the eco-techniques can reveal *life-hope* and *life-meaning* (Foster, 2008). These concepts are a call to create consciousness to frame ethical values in visioning future scenarios. Life-hope aligns with the concept of *biophilia,* resulting in a path to recognize the connections that human beings subconsciously seek with other life forms in common end, or in other words 'design for nature'. On the other hand, life-meaning aligns with the strategy of 'design with nature' as a premise, aiming for an understanding of the language of animals, plants, bacteria and ecosystems as innovative tools, which is precisely the output of *biomimicry.* There is also the idea of *resilience* that weaves the idea of 'change along with nature'. Resilience encourages us to acquire a natural rhythm in our human intention and technologies by creating a sense of cooperation in order to thrive.

Connecting these three concepts projects a 'naturalistic' transition that we require for the well-being of human and non-human societies, known as *bio-synergy* (Mathews, 2011). Implementing these as eco-pedagogical practices proposes to help generate the eco-literacy required for the future, and, by doing so, form new profiles of the designer of the 21st century. With these new ecopedagogies as input, the design academy will be capable of building ethical values, strengthening creative practices and providing critical views in decision-making about technology. As outputs, future graduates will be proficient in creating objects, communications or services that will reframe worldviews, principally establishing a re-connection with nature, the implementation of healthy innovation and crafting co-evolution with the planet. Figure 2 (below) illustrates this correspondence.

What if design educators promote the connection of ecosystem interactions with digital interactions? What if our methods of prototyping look "through the eyes" of a red squirrel? What if teaching is undertaken in nature reserves or botanic gardens? The more conscious we become of the secrets of nature embedded within our *practical consciousness* (Giddens, 1986), the more prosperous our society will be. We require a shift to thinking about innovation inspired by nature, so that artefacts, communications and services can be projected into bio-integrative technologies. Biophilic cities, biomimetic objects, metabolic services and ecosystemic interactivities will be part of a new vocabulary in design, which could reframe the symbiotic element of our culture.

This strategy is then an appealing image of crafting our future where our recognizable biological ends look to maintain an ethical commitment along with our educational systems. We need to begin to establish programmes, modules and the conformation of design communities that consciously bring a fundamental basis to promoting flowing change within nature and the limits of technology that human intention requires, thereby crafting a meaningful human presence on planet Earth. This model places design in a participatory mode aimed to stimulate the development of new methods to facilitate nature-based knowledge and behavioral change. Integrating these practices in the design academy on a continual basis will bring a new vital consciousness which will encourage design students and academic practitioners to ‘design with-in nature’.

Eco-technics	Input by academia	Output for society
Biophilia	Life-hope ethical values	Re-connection with nature
Biomimicry	Life-meaning creative practices	Healthy innovation
Resilience	Technological Bio-rhythm	Crafting co-evolution

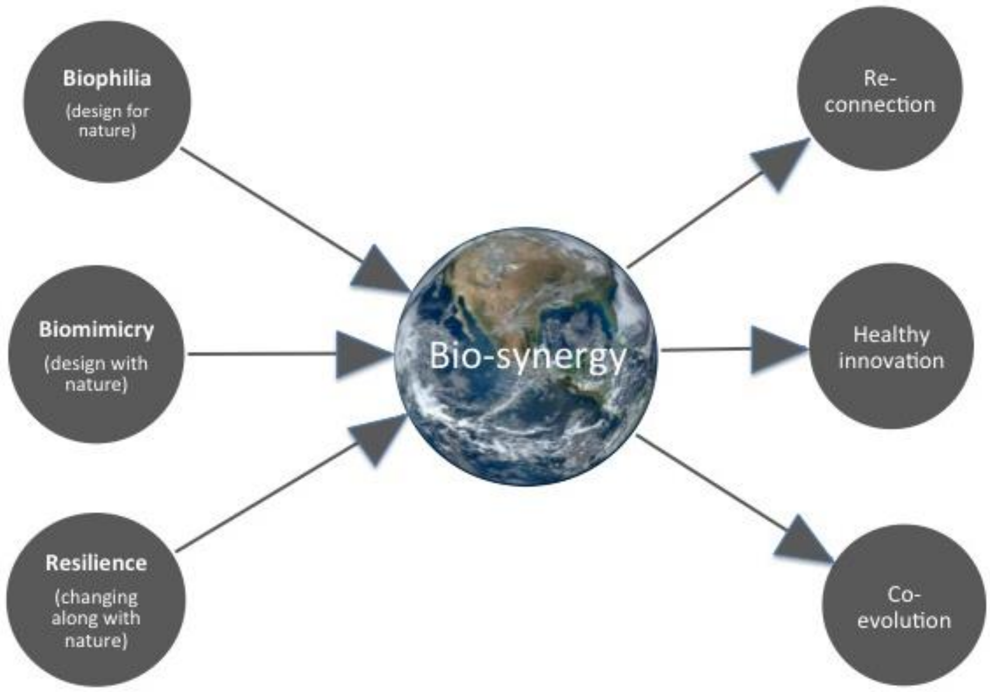

Figure 2. Bio-Synergistic dynamics

The diagram demonstrates how the interaction of eco-techniques as inputs generate bio-synergy, to then facilitate co-evolution, healthy innovation and reconnection with nature required in our society.

1.3.1 The new profile of the ecological designer: A participant of a living planet

As we approach the transformation of the education system through ecological wisdom, what then will be the profile of the designer of the 21st century? Designers can be seen as 'synthesizers whose craft is to respond to the various design requirements in integrative and holistic ways' (Vol 1 A-H *Encyclopedia of creativity.*, 2011, p. 525). As ecological design permeates a shift in worldviews. Precisely is how aspirations and intentions confront how we are teaching 'to be critical about narrow or holistic worldviews' (Wahl and Baxter, 2008) as a design pedagogy.

There is still the problem of integration of ecological thinking into design education in forming the new profile of the designer. We can identify 4 elements that help to reveal the new profiles:

1. Individuals recognizing the self as natural beings
2. Individuals and groups willing and open to learn from nature
3. Acting in uncertainty and complexity as part of the Earth community
4. Becoming one with the world in every creation

As the design academy fosters creatives, it also needs to form *wise* individuals by developing several new characters. Emergent positions for design in the 21st century were studied by a group of researchers from different universities in the UK (Inns, 2007, pp. 11–26). Through this initiative, four new emergent positions and six emergent roles were postulated for the designer. The emergent positions are summarized in the following figure (fFigure 3):

Figure 3. Development of metadesign disciplines (Inns, 2007)
In this figure, an external cluster of metadesign disciplines represents a driver between existing discipline silos, which is where design ethics, sustainability and ecological design itself can be situated.

The new emergent roles for the designer in the 21sth century, as suggested by Inns, are described as follows:

- Designer as negotiator of value: Here the designer has an important role to play in negotiating decisions within complex situations. Value is however increasingly multi-dimensional, for example, we must consider ecological and ethical dimensions.
- Designer as facilitator of thinking: Enhanced facilitation skills are another addition to the designer's growing portfolio of skills in a 21st century context. The designer will need to know how to mobilise and energise the thinking of others.
- Designer as visualizer of intangible: Although the contemporary designer already visualizes and synthesizes future possibilities, they still need to make association with the visualization of the abstract and the intangible (systems, experiences, emotions and so on) and to find ways to communicate these

intangible concepts with others. They also need to find ways to prototype them, test them and implement them.

- Designer as navigator of complexity: The interdisciplinary world is one of complexity and ambiguity. The designer can help others to understand complexity, but also an appreciation of complexity theory will help designers to understand their own role.
- Designer as mediator of stakeholders: Increasingly the designer is able to become a mediator of solutions for multiple stakeholders who often have different perspectives, needs and expectations.
- Designer as coordinator of exploration: The designer has always played a leading role in planning future outputs, including, for example, concepts, prototypes and plans for future implementation and production. The 21st century designer must be able to coordinate exploration of ideas between the technical, the ecological and the contextual.

Through analysing these emergent profiles of the designer of the 21st century and, by correlating them with the ecological techniques presented earlier, we can postulate four other emergent profiles as follows:

The biophilic being. To engage the individual self with nature, we open our minds and organic bodies to receive the teachings. Becoming an ecological designer implies a preparatory stage that is immersive and experiential, thereby allowing the worldview to change.

The biomimetic practitioner. As we are more open to learning from nature, we begin to enhance our creativity by developing concepts and solutions inspired by the wisdom and interrelationships with a more-than-human world.

The resilient thinker. As we face uncertainty, we begin to realise how resilience thinking is fundamental to allow the designer to picture design ethics along with the visions of the future in every design that is created.

The symbiotic designer. This profile occurs when the designer's ecological integrity is recognized when designing becomes meaningful. The individual self and the collective self become one with the living world and with the universal truth, flourishing along with life.

Through further analysis over the following chapters, these four profiles will be considered as the integrated essence of the new profile of the ecological designer. The need now is clear. The design academy needs to make a transition or revitalization of its design pedagogy by bringing new alternative and conventional practices together. The eco-techniques suggested here might be the ones that provide that transition to theory and praxis for ecological design and the acquisition of new profiles.

1.4 Relevance of this research for Design Education

Broadly, this research explores the association of design principles and ecological theories. It draws on the information from eco-pedagogy and several eco-philosophies. Design principles enunciated by, for example, John & Nancy Todd (Todd, 2006), Janine Benyus (Benyus, 2002), David Orr (Orr, 2004a), Stephen Kellert (Kellert, 2012), Lynn Margulis (Margulis, 1999) and other eco-literates are included as ecological principles for the formulation of this new design methodology for teaching and designing.

These explorations on symbiosis expanded the initial focus on biomimicry into the quest for symbiotic responses through design. Focused on this concept, this research intends to facilitate theoretical-practical reflections on recognizing the innate response of being creatively human by learning in close association with the natural world. In essence, the aim is to develop and use existing educational material that facilitates nature-based experiences and behavior changes toward ecologically conscious civilization.

This methodology has been examined and tested for its role in stimulating imagination and inspiration in design students with regard to embodying a greater awareness and better understanding of scientific knowledge and technological development, and ultimately ecological wisdom. In order to test and emphasize the acquisition of these ecotechniques, examples are postulated in four general chapters as the *biophilic being*, the *biomimetic practitioner*, the *resilient thinker* and then formulated into the notion of the *symbiotic designer*. Descriptions of educational material designed for the workshops are also included.

Many of these concepts have been developed by scholars at the Centre for the Study of Natural Design at the University of Dundee and all seem to be inherent features of ecological thought. A special effort has been made to explore in practice and to expand the relatively underdeveloped aspects of ethical values in relation to biophilic design (Kellert and Wilson, 1993), naturalism in design (Powers, 1999), and resilient societies (Hopkins, 2011), all aimed at *enriching* the profile of the ecological designer.

In brief, this research is relevant to the following purposes:

a) To create, reshape and strengthen design curricula.
b) To encourage cross-disciplinary research between the arts and the sciences.
c) To improve individual (students) communitarian (facilitators) and global (bio-cultural) well-being.
d) To develop the future profile of the ecological designer.

The hope and final intention with this research is to generate a feeling of positive healing for our planet through design education, not only at university level, but also beyond, where the alternative schools and communities are beginning to shift the current paradigm to that appropriate to an Age of Enlivenment.

As we move toward an ecological worldview, the designer's conventional way of thinking will be forced to change, thereby resulting in a breakdown (Goldsmith, 1996, p. 440) in the system of beliefs. In the same way, the design academy might experience a similar shift in values. The ***Symbiotic Design Practice*** process explored here may help to facilitate a smooth transition for the individual and the institution.

Ecological design education and its pedagogy are meant to educate designers to think broadly, to perceive systems and natural patterns and to live as integral persons. It is situated in the wildest possible context, encouraging creative beings to be wise. The redesign of the education curriculum, especially in the design academy, is the challenge of our time. This kind of reformation will help us to evolve ecological design as a set of design skills that transforms lives and the way we inhabit the Earth.

1.4.1 Research Aims and Objectives

The **main aim** of this research review is to consolidate the theory and practices of nature-based design and experiences in order to develop a series of teaching/learning strategies and practices that enhance the embodiment of <u>designing with-in nature</u>. This practices were tested and evaluated across a sample of design students, e.g. graphic design, product design, crafts and so on.

1.4.2 Research Questions

The research question is about asking how design education can move from using nature, just as a source of aesthetic inspiration, to an act of designing with-in nature? **In particular**, this question explores which methods of teaching and learning that contribute most to the designers' transformation toward a new design ethos, where design practice and thinking now includes ecological thinking. Finally, the research question proposes to postulate new profiles for theecological designer.

The research objectives are:

- To consolidate the research literature on biomimicry, biophilia, resilience and symbiosis, and other related concepts to be considered as eco-technics.
- To construct an audit of practical examples (visuals), principles (texts) and workshop exercises.
- To pilot this material on a sample of design students at DJCAD.
- To devise suitable recording and evaluative procedures for assessing the outcomes of the trials.
- To design a range of methods for testing and evaluation which will cover a wider range of students and disciplines.
- To produce a sample of learning tools and texts.

Finally, there are four tasks this thesis aims to accomplish. Firstly, that the emerging field of Biophilic design, will go "hand-in-hand" with biomimetic design in order to promote ethical ways of designing and balancing the psychological and spiritual basis of communities and their economies. Secondly, that biomimetic design and all related synthetic aesthetics will not just serve human communities but non-human societies too as a principal ethic. Thirdly, that the concept of resilience thinking in the design disciplines will uplift these ethical dimensions to enable design to embrace complexities, such as the natural patterns of our planet, climate change, the actions of high technologies and positive thinking about the future. And finally, that the concept of symbiosis will be incorporated into design education, thereby ensuring the integration of the first three eco-techniques, all of which are aimed at facilitating co-evolutionary efforts between humans – including their technologies – and non-human beings, for the well-being of the living planet.

The knowledge from this thesis will contribute not only to the juxtaposition of these concepts, but also to their practical understanding in forming an ecological profile for future designers, thereby providing facilitators with solid theoretical-practical skills about design ethics, sustainability and ecological design itself.

Chapter 2. Framing a symbiotic design inquiry: Research rationale and methodology

2.1 A symbiotic design inquiry

The previous chapter provided the preamble for the philosophy of this research, which is intended to promote the pedagogical duty of the design academy in the development of ecological literacy. This chapter describes the theoretical and methodological rationale used for the interpretation and implementation of this research study.

If we acknowledge that everything is interconnected in a complex world, it is in the ontology of ecological design that we are able to find some of the answers. For this reason, the procedures or methodologies integrated in this study explore the ecological pedagogy in design in order to acquire new ways of seeing and making sense of the world.[16]

The eco-techniques studied here have been placed in the domain of qualitative research (Creswell and Creswell, 2013) , which helps to guide and connect the ontological and epistemological aspects of this investigation. The empirical evidence gathered (in Chapters 3, 4, & 5) through observations and personal experiences of exploring these eco-techniques has helped to form conclusions on the notion of *Symbiotic Design*, as a theoretical concept, design practice process[17] and pedagogical framework[18] (as will be discussed later in Chapter 6).

[16] For more information about ontology and epistemology issues, see: (Arthur, 2012, pp. 16–19).
[17] In the context of this study, a **process** is defined as a set of interrelated activities or steps that interact to achieve a result (Oxford dictionaries, 2016). The helix-like diagram of the SDP is itself a *process* "framed" within a series of concepts or techniques to achieve symbiotic design.
[18] In this study, the meaning of **framework** or conceptual framework refers to making a conceptual distinction and organize meaning (Ravitch and Riggan, 2016) In this case, it is to capture the ecotechniques here defined in a coherent and useful way, in a way that is easy to remember and applied by the design practitioner or educator. It is a type of model of operation based on action research.

The methodological rationale aims to change the notion of learning from nature to learning with-in nature. Such ways of learning require a transformation of our educational ideals by embracing the practical capabilities to act creatively with-in the world. This should subsequently lead to a deeper understanding of what it means to be human while creating a sense of mutualism with all living systems, thereby helping us to flourish.

In the context of this study, the research approach incorporates aspects of scientific, political, therapeutic and the aesthetic (Arthur, 2012, pp. 8–9):

- Scientific, as it supports, builds and tests theories related to ecological thinking;
- Political, as it aims to improve pedagogical approaches in design education;
- Therapeutic, as it provides support for the design student (and subsequently the professional) to design with meaning and question their intentionality; and
- Aesthetic, as it aims to affirm and represent human experience for designing by following patterns of nature.

This study can also be grounded in empirical and theoretical traditions (Arthur, 2012, pp. 9–10). Empirical, as it is grounded in observations and data analysis gathered during a series of exploratory workshops; and theoretical, as it interweaves the philosophical background of the eco-techniques explored and taught through the idea of a pedagogical framework, which also complements an on-going literature review.

Overall, this research study was designed as an action-based inquiry (McNiff, 2001). It focuses on educational action research as a strategy for the development of teachers as researchers so that they can use their research to improve their teaching and thus their students' learning (Tripp, 2005). Action research is an approach that has practical-theoretical outcomes (Elliott, 1991). It can be undertaken by practitioners, such as teachers, social workers, students or service users as insiders or facilitators serving as a catalyst (Winter and Munn-Giddings, 2001). Action researchers commonly use a mixed-method approach when analysing data and are primarily concerned with learning and implementing change rather than constructing an interpretation. These working principles readily translate into an education setting (Munn-Giddings in Arthur, 2012).

Originality

The platforms selected to develop and test this study were a series of interdisciplinary teaching modules at undergraduate and taught postgraduate levels at Duncan of Jordanstone College of Art and Design (DJCAD) at the University of Dundee, along with other external postgraduate events (to be described in the following sections). The initial idea was to explore, test and develop diverse methods on ecological techniques in order to create a practical educational toolkit (materials, exercises and texts). The idea later evolved into a new methodological framework to design ecologically, and also as an ecopedagogical framework for teaching ecological design. This synergistic triad can be considered an original contribution.

Validity

Teaching a new module, called 'Design Values, Issues and Ethics', provided an opportunity to test the ecopedagogical framework. Literature reviews, workshops with multiple units of exploration and questionnaires, provided a valid inference about the causal effect of ecopedagogical actions without requiring any statistical modelling assumptions. The practices designed and the data collected over 3 years of research provided informed pedagogical outputs on ecological design techniques. Design Education conference papers (see Appendix A.1), internal evaluations and award recognition for the module by the University of Dundee (see Appendix A.2) also demonstrated the construct validity (justification) of this research study.

Research Strategy

The research strategy aligned to the research question in a teaching and learning context. It involved an 'action inquiry cycle' (Tripp, 2005) where the researcher plans, implements, describes and evaluates changes to one's practice (see **Error! Reference source not found.**4).

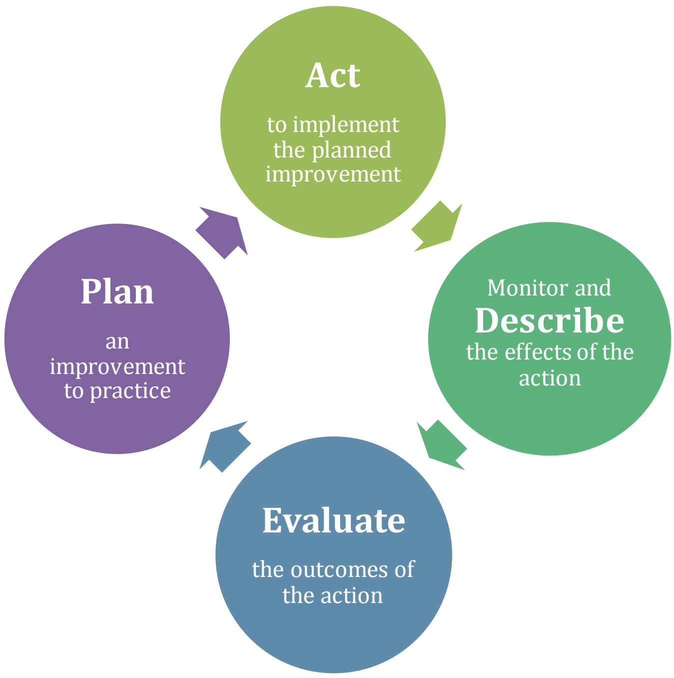

Figure 4. The 4-phase representation of the Action Inquiry Cycle (Tripp, 2001)

As shown in the cycle above, the planning was the first step for 'systemic reviews' and 'a series of workshops'; the implementation of these was the acting step, the description of the effects of the workshop through refining of educational material was the subsequent step; and, finally, the evaluation (questionnaires) by the students and the researcher in the educational environment were part of the action-based cycle.

The original research question addressed in this study to develop an action-based research methodology was: how can design education move from using nature as a source of aesthetic inspiration, applied simply as a catalyst to artistic problem elaboration, to the act of designing symbiotically with nature? In particular, to explore which methods of teaching and learning contribute most to the designers' transformation toward a new design ethos where design practice and thinking now includes ecological thinking. The following diagram explains the research process (See Figure 5):

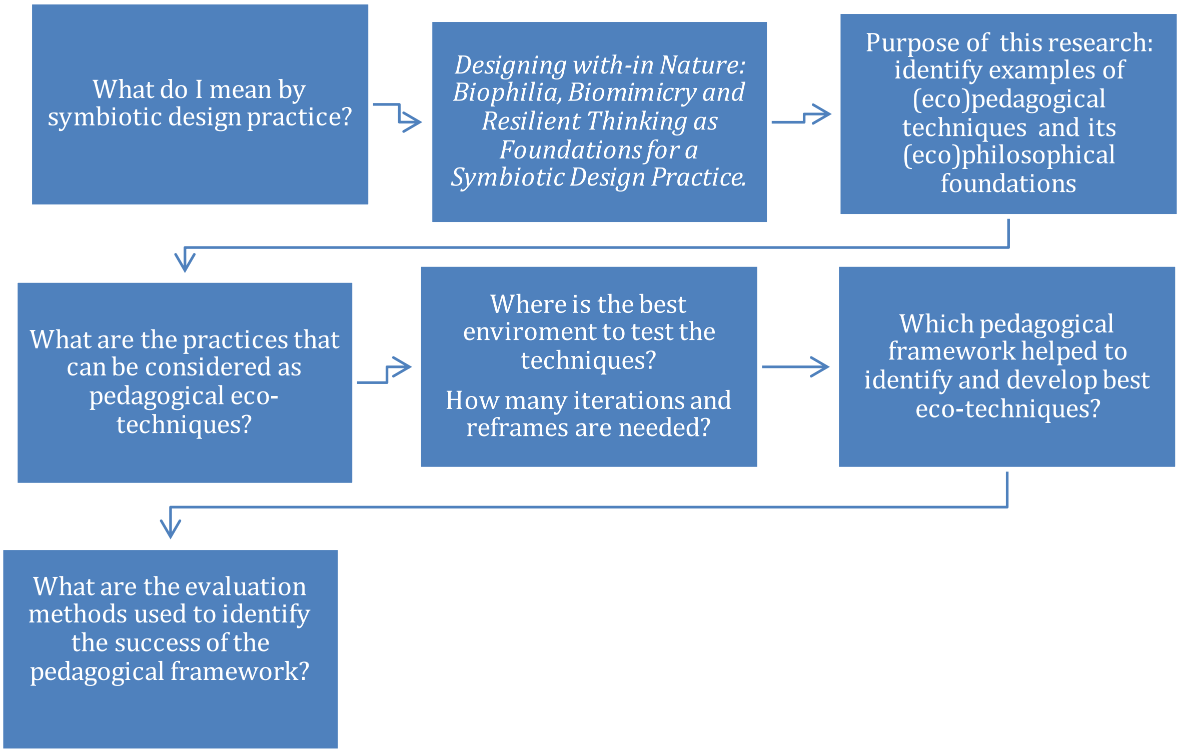

Figure 5. Research Question Process

This research inquiry is grounded in qualitative research derived from humanities, but also uses the lexicon "borrowed" from natural, environmental and holistic science, which therefore frames this research into an interdisciplinary ecological design study. The methodological model (or framework) presented, demonstrates how ecological design can attempt to address complex (or 'wicked') problems that we face today. As a result of using a range of interdisciplinary methods and a different perspective (or worldview), eco-techniques are identified and adopted.

Therefore, the methodological approach proposed for this research study for 'designing with-in nature' aims to assist in finding a common ground for the arts and the sciences whilst enhancing the ecological epistemology in design practice (See Figure 6)

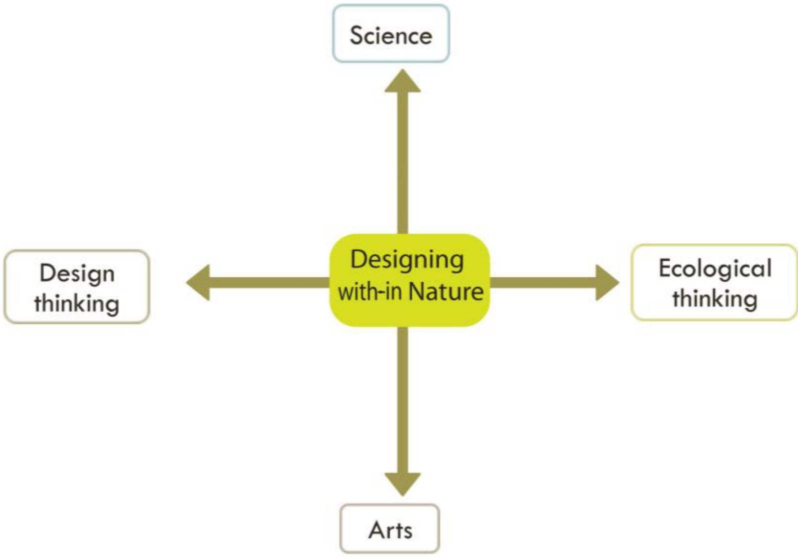

Figure 6. Designing with-in-nature dynamic
Design thinking, whilst expanding into new domains such as business and management, remains incomplete unless it embraces ecological thinking and expands integrally between the arts and sciences.

The review and consolidation of the theory and practices of biophilia, biomimicry and resilience were used to develop a series of pedagogical strategies and practices, which were then framed as the embodiment of 'designing with-in nature' or *Symbiotic Design*. These practices were then tested and evaluated across a sample of undergraduate (level 3 DJCAD) and taught postgraduate (MSc Service Design and MSc Design Ethnography) design students at the Dundee Botanic Gardens, and within design studios and at other postgraduate related events.

Over three years of iterations or 'action-based cycles,' allowed for a flexibility of change in order to build on the eco-techniques. Such iterations helped to develop text, visuals and related didactic practices. Moreover, teaching at the Dundee Botanic Gardens, as a main classroom, allowed immersive experiential learning to take place, thereby helping to reaffirm the ecological literacy theory that was taught.

The purpose of this research is also exploratory. In other words, the focus was to examine the **feasibility** of an eco-pedagogical framework and **provide illumination** (Robson, 2011) on the process of exploration. The data collected, and the interpretations of the findings, are therefore based on personal experience and reflection over the three years of teaching and delivering the workshops on the interdisciplinary modules. To some extent, the *Symbiotic Design* Practice is open to be explored, reframed and criticized by academics and practitioners. However, it is posited here that, in the absence of a suitable framework, this is a foundation that can be built upon in future studies.

Compiling, evaluating and interpreting the literature review and translating it into an educational methods framework can be described as a phenomenological approach (Cohen et al., 2011; Creswell and Creswell, 2013). The deductions, observations, tests and evaluations described throughout this chapter are designed to validate the proposed development of a '*Symbiotic Design Practice'*. As this practice embraces the idea of 'designing with-in nature' as a philosophy, it is linked to the 'appreciation of our living world in everyday life' as described by Husserl (cited in Cohen et al., 2011, p. 30).

The ontological basis of this research framework embeds a pedagogical philosophy connected to the personal experience of the researcher, both as a design educator and an ecological designer. It represents a quest to identify and facilitate the development of educational tools, methods and principles that incorporate ecological design theories and practices. This diverse range of tools are mainly to be used in classes or modules to support the integration of design practices with ecological literacy (or related holistic approaches that represent a critical transformation of the design student by learning with-in nature).

Predominantly, the research epistemology is encapsulated in deep ecology philosophy, as it lies 'in understanding the unfolding process of learning, experiencing, and self-realization' (Naess, 2010). It also embeds the Integral Theory framework explained by Wilber (2000) as a means of integrating any human knowledge domain into everyday practice (See Figure 7). It progresses from the self (I or individual), the exterior world (IT or the other), the collective culture (or the WE) and its exterior social aspect (or the ITS).

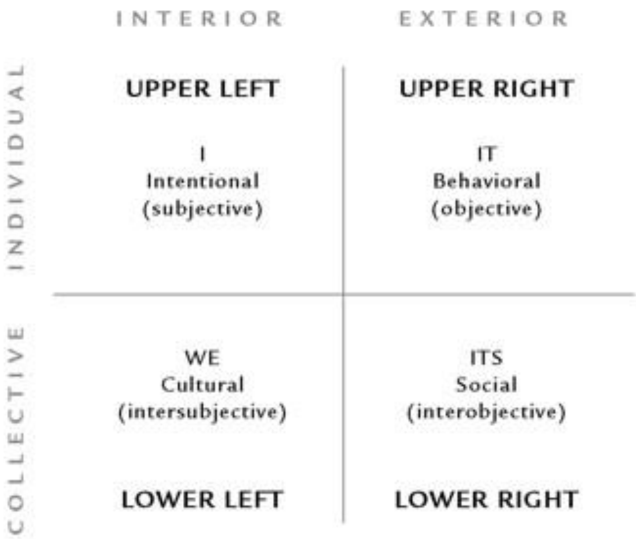

Figure 7. Integral Theory Quadrants by Wilber (2000)

The four incorporated eco-techniques – biophilia, biomimicry, resilience and symbiosis – align to the design inquiry, and the approaches from the self, collective, planetary and cosmos levels, are all in reciprocity between the ecological individual and our planet (See Figure 8).

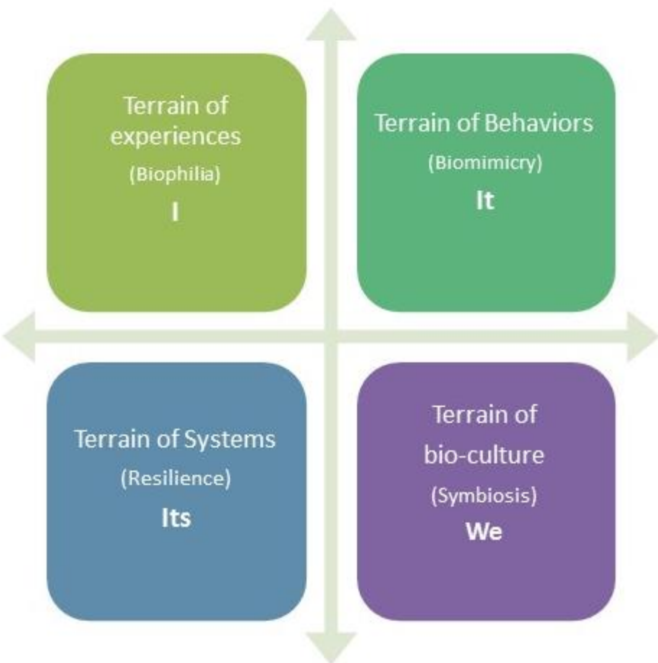

Figure 8. Four terrains of Symbiotic Design

In Figure 9 (below), the way in which this has been incorporated into the notion of ecological wisdom – awareness, understanding, action and legacy – aligns to the teaching/learning mandala and the four integral stages of the eco-techniques. The individual level (I) is related to biophilia because it exposes the inner need to belong to nature. The communitarian level is about human-nature relationships along with the intention to create artifice with other (it) organisms, all reflected in biomimicry. Resilience is the response to changes caused by human phenomena and natural phenomena, is to see how changes/cycles are embraced along with nature (its). Once all levels have been recognized, they then need to be fused into a single notion to work together symbiotically in order to teach and learn to *design for a flourishing planet (eco-pedagogy).*

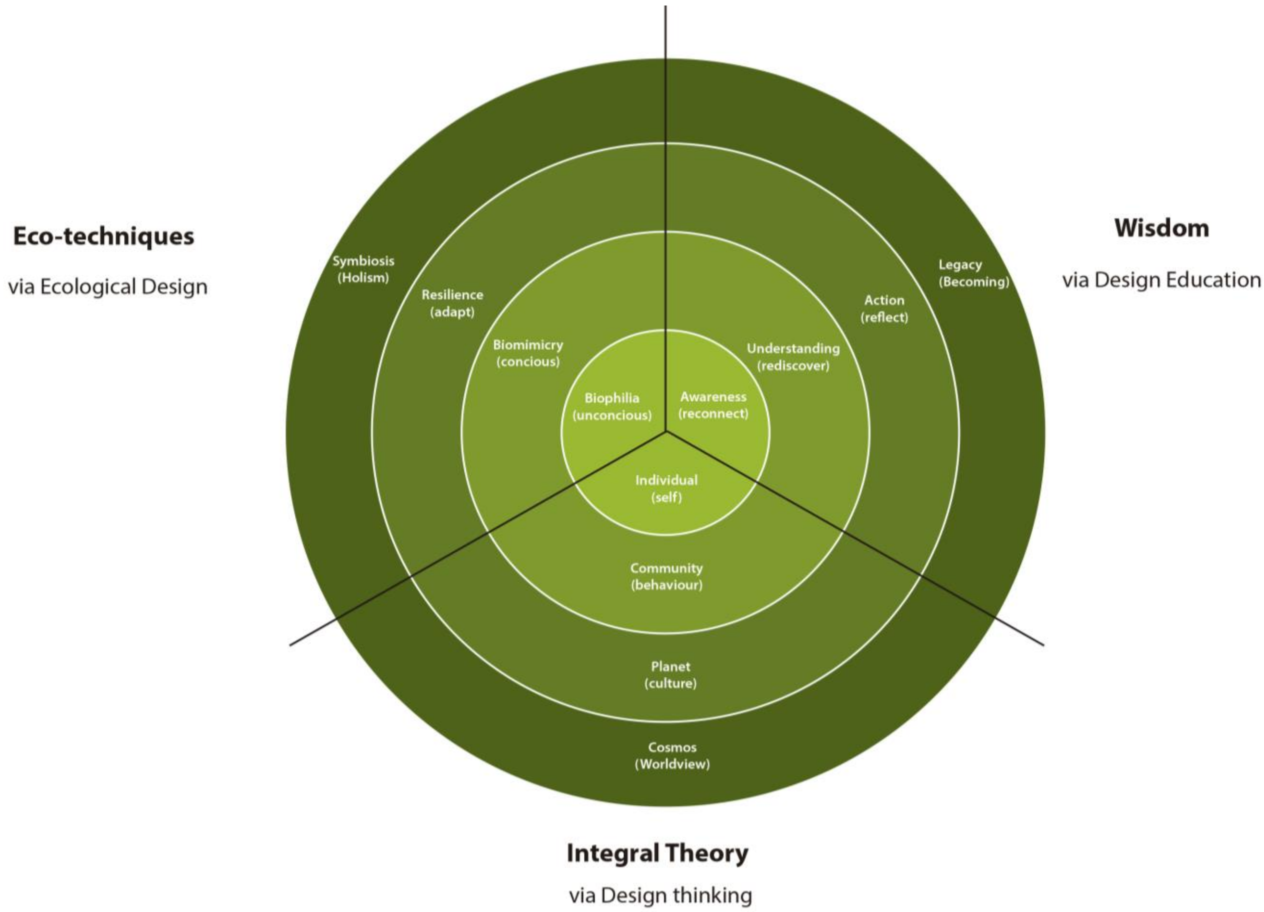

Figure 9. Symbiotic Design Practice Framework (mandala)
This mandala helps to visually locate the eco-techniques, the learning process toward wisdom and the amalgamation of integral theory with the design domains, in order to achieve a *Symbiotic Design Practice* within related levels.

2.2 Integrating the eco-techniques: Framework development

A synergistic diagram to explore the conformation of this ecopedagogical framework was required. The ideas to integrate the three eco-techniques[19] were initially explored through the concept of bio-synergy (Sanchez Ruano, 2013). Furthermore, the diagram later evolved to integrate the concept of symbiosis as a more theoretical-practical tool as a *Symbiotic Design Practice* process. The resulted SDP diagram (See figure 12) incorporated a more integral rationale with the analysis of design thinking processes. The design thinking process developed by the Stanford D. School (Plattner et al., 2013) (See Figure 10 below), the Design Council's "Double Diamond" design process model (Design Council, 2015) (See Figure 11 below) and the Integral Theory Quadrants (as in Figure 8) helped to develop a clear framework to incorporate a design process and aligned to the phases required to integrate the concepts of biophilia, biomimicry, resilience and the idea of symbiosis. The diagram also helped to visually communicate the structure of each workshop to the students.

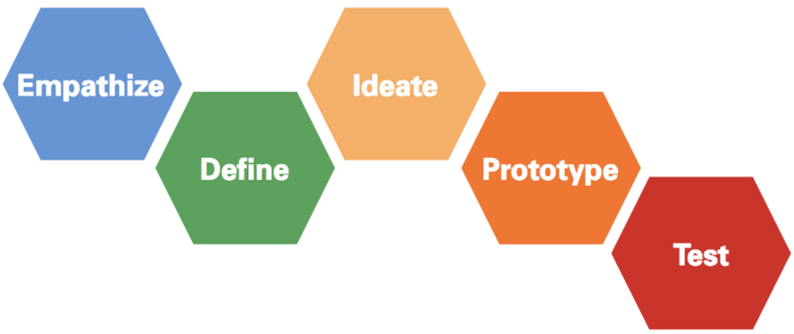

Figure 10. Design Thinking Process Model by Stanford D. School (2013)
This process has been developed in order to guide the successful design of products and services in a systematic way. The process is broken down into specific stages with key activities and goals. The originality of this process is perhaps the Empathize stage (or understanding the perspectives of others).

[19] This was one of the first explorations for the study presented in poster format at the "Connecting Futures" conference which took place in 2012 at University of St. Andrews, UK. It was later disseminated as a conference paper at the European Academy of Design (EAD), "Crafting Futures" in Gothenburg, Sweden (see Appendix A.1).

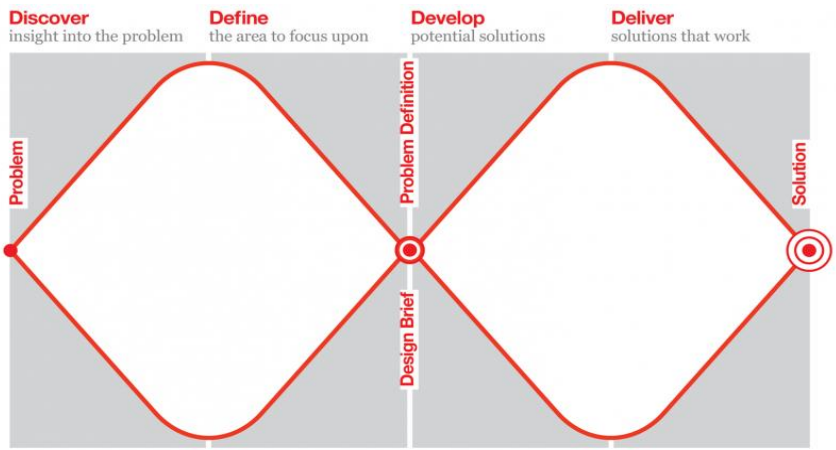

Figure 11. Double Diamond Design Process Model by Design Council UK (2011)
This design process model facilitates how we discover and define the design brief and the effort required to develop and deliver a meaningful solution in a divergent and convergent way through each of the phases.

The SDP process (Figure 12) brings together four phases which represent the four areas of ecological wisdom: 1) Awareness; 2) Understanding; 3) Action; and 4) Legacy, which subsequently exposes four areas of 'self-realization': 1) Reconnect; 2) Rediscover; 3) Reflect; and 4) Becoming.

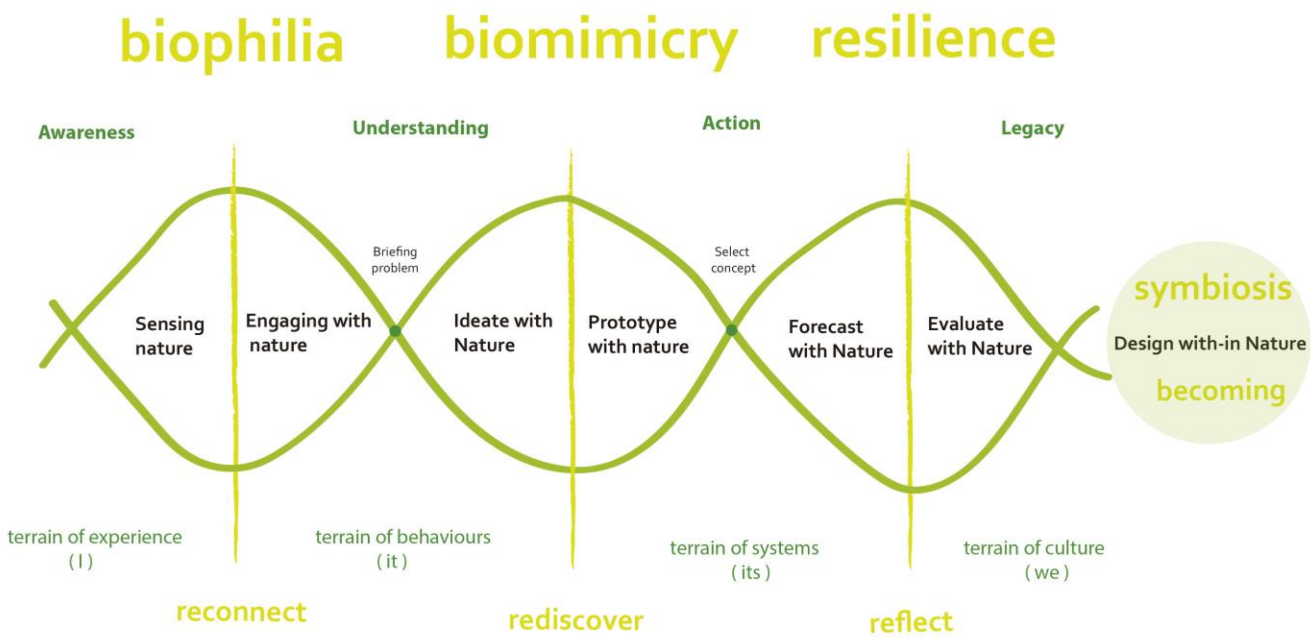

Figure 12. The Symbiotic Design Practice (SDP) process
This diverging and converging process model includes 3 stages, 4 phases and 7 steps to achieve *Symbiotic Design*. The model can also help the reader to navigate through the remaining chapters of this thesis in a clear and consistent way.

Initially, three areas to achieve ecological wisdom were defined: awareness + understanding + action (Baxter, 2013). In addition to this rationale, and through the study of integral theory (Wilber, 2000), the fourth area: legacy, was introduced. Here, awareness + understanding + action =/+legacy can then be framed and homologized with the notions of Biophilia + Biomimicry + Resilience =/+Symbiosis. After having identified these concepts as an eco-pedagogical framework, the four phases were aimed at transcending the conventional design curriculum. We can describe them as follows:

Phase 1. Awareness/Reconnect/Biophilia

The **awareness phase** is the one in which we become enlivened. What is stimulated is the sense of being alive with the world, the feeling of our humanness, an experiential phase in which our biophilia is discovered and accepted. It is the very personal level of consciousness and the senses; here, empathy with the non-human. This phase goes back to our ancient roots and into our natural history.

Teaching students how to be aware of nature and to develop self-realization of 'being nature' as individuals, requires the development of deep ecological practices. The study of biophilia as an eco-technic focuses on the development of "How to teach an awareness of all living things?", meaning that as individuals we must be aware that we are part of a bigger living entity and what we do as designers or memes is to replicate the world itself and be 'in' it using our senses and mind consciously. This preparatory 'reconnect' stage begins by using biophilic activities at an individual level, the integral self (I). It includes 'empathy' within the context/user stage, similar to how design thinking is established (Stanford D. School, 2013). However, it is more focused on empathy with the self in nature.

Phase 2. Understanding/Rediscover/Biomimicry

The **understanding phase** is when we recognise that, without identifying ourselves within nature, our creativity is poor. By learning from nature, we commence to identify the 'patterns that connect' with every creation. Here, the biomimetic lens is activated and we begin to design *with* nature. We identify the non-human intelligence thriving and as the embodiment of the same living patterns. This is to understand natural designs in our practical consciousness.

At this stage, the designer generates concepts with meaningful intention as a part of a living planet. In other words, the idea is to create meaningful inventions and interventions while reflecting nature's way in objects, built environments, services and messages, as a virtuous <u>understanding</u> of the aesthetics of mimicking life's patterns. The biophilia phase converges by defining and reframing the design problem, as in the Double Diamond Design Process Model. The divergent processes of biomimicry exploration begin by igniting curiosity to rediscover nature's patterns in an 'ideation' stage, similar to the Design Thinking Process Model. This stage is practiced along with other organisms that the designer encounters in nature, the integral other (it). The organism is the co-designer.

Phase 3. Action/Reflect/Resilience

The **action phase** is to see our human creative capacities as a gift that needs to be given with meaning 'for' the world. Here our technological-oriented perception becomes the ethical limit, going beyond the evaluation of consequences to adapting to the natural rhythms and becoming a gentle positive change. It implies a past-present-future dynamic.

Acting ethically whilst addressing real world issues is ultimately the goal of good design practice. Moving from fiction and fragmentation to an integrated, holistic way of working or even from accelerated to slower scenarios is a way of transforming the pace of technological change in designing new things. The concept of Resilience, as a third eco-technique, can show us how we can learn to <u>act</u> now and into the future. This reflective phase becomes fundamental for designers as the integral collective self (its), and manifests the need to design for our living planet and its inhabitants. The biomimicry phase converges by selecting the design concept or prototype as in the Design Thinking Process and the Double Diamond Design Process models and then diverges again in the forecasting stage of resilience.

Phase 4. Legacy/Becoming/Symbiosis

The **legacy phase** implies a mutual effort toward symbiosis. 'Becoming one with the world' is the ultimate muse to design holistically and wisely. Designing together with the wold, letting the more-than-human world help us to design, and letting the more-than-human world to design itself is a dynamic conversation in our symbiotic consciousness. We are alive because we are together and we create together.

Including the notion of Symbiosis as a conclusive eco-technique means a shift in the way we design in the 21st century. It incorporates the previous three eco-techniques into the process of reflection. Collaborating with nature and being part of its design leads to a metamorphosis that design students need to experience but also learn to inherit, as a metadesign method for future generations. Here, the design project is concluded in the reflective, evaluative stage of the design. Integrally, the planetary self (We) converges by 'becoming with-in' the whole, becoming symbiotic, belonging to the Earth.

It is argued throughout this thesis that adopting the *Symbiotic Design* Practice process (D) can help design educators to integrate ecoliteracy into their design thinking processes and programmes. In other words, designers should learn to reconnect with nature through Biophilia (A), rediscover life's patterns through Biomimicry (B). This demonstrates that Biophilia (A) leads to Biomimicry (B) and by incorporating resilience thinking (C), we are likely to achieve symbiosis with the world through designing (D). Simply put, A+B+C=D. This simple equation, therefore, positions this study so that the components can be examined through induction, deduction and abduction (Berger, 2014). This means that without Biophilia there is no Biomimicry, and that Biomimicry alone is not enough to build Resilience. In the first instance, B+C will be incomplete because it does not contain A. Biomimicry can integrate with Resilience thinking, but requires the deep ecological input that Biophilia builds.

Although the SDP process has been implemented in a linear fashion, it is very flexible. Sometimes the teacher or professional designer can start with Biomimicry practice and continue with Resilience and conclude with Biophilia but it is important to always end up reflecting in Symbiosis. In other words, it can start with a brief to deliver a biomimetic project for example, continue with systemic thinking with Resilience and conclude with engaging ways to relate to life through biophilic activities. In the same way, the SDP process can start backwards by being placed in the bigger picture of a problem or design, reflect through resilience, address it through biomimicry methods and then reinforce the process with biophilic practices as a reflection (See Figure 13 below).

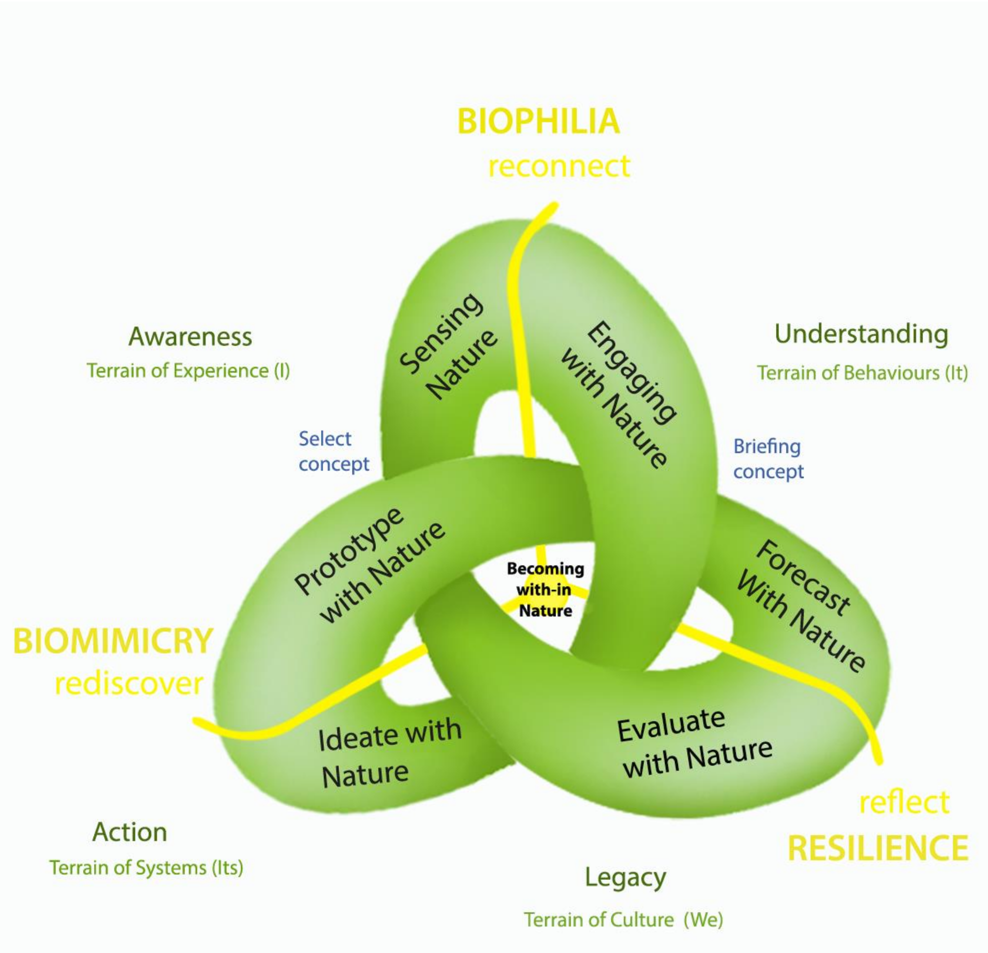

Figure 13. Symbiotic Design Practice node
This node diagram represents the use of the SDP in an integrated non-linear modality. The practitioner can begin to explore the eco-techniques at any point but always continue to integrate them.

2.3 Implementing eco-techniques: Research methodology process

The integration of this practice was developed in a series of iterative pilot and formal workshops over three years with an established undergraduate expansive module, a number of master classes at DJCAD and during a postgraduate conference. The workshops provided the platform to observe, explore, analyze and reconfigure these eco-techniques in the theory of *Symbiotic Design* and to create a solid design practice for the future implementation of new modules, programmes and other related pedagogical strategies (as will be discussed in the final chapter). This research strategy helped to clarify any presuppositions in order to refine the SDP framework.

Research Context

Exploring the possibility of implementing the *Symbiotic Design Practice* framework into the pedagogical practices in HEIs required an academic mode of application and experimentation shaped into a 'series of workshops'. A full learning module at an undergraduate level, along with a number of master classes with postgraduate students from DJCAD at the Botanic Gardens at the University of Dundee and at an international conference formed the academic platforms from which to develop the study and also served as a way of reframing content and the use of the educational material.

Research Format

The initial format of the workshops was born out of the intention to provide the students with a new set of tools for 'design inspired by nature'; a quest to encourage and stimulate them to acquire new worldviews in relation to their creative practice by learning how nature does design. Collecting the data from these pilot workshops justified the initial bio-synergistic design practice by adding biophilia and resilience thinking. Additional formal workshops, and the intention to create a teaching toolkit, later resulted in an ecopedagogical structure in the form of a series of action-based steps, all conducted through the series of workshops. The following diagram (Figure 14) explains the methodological development in an action-based learning cycle.

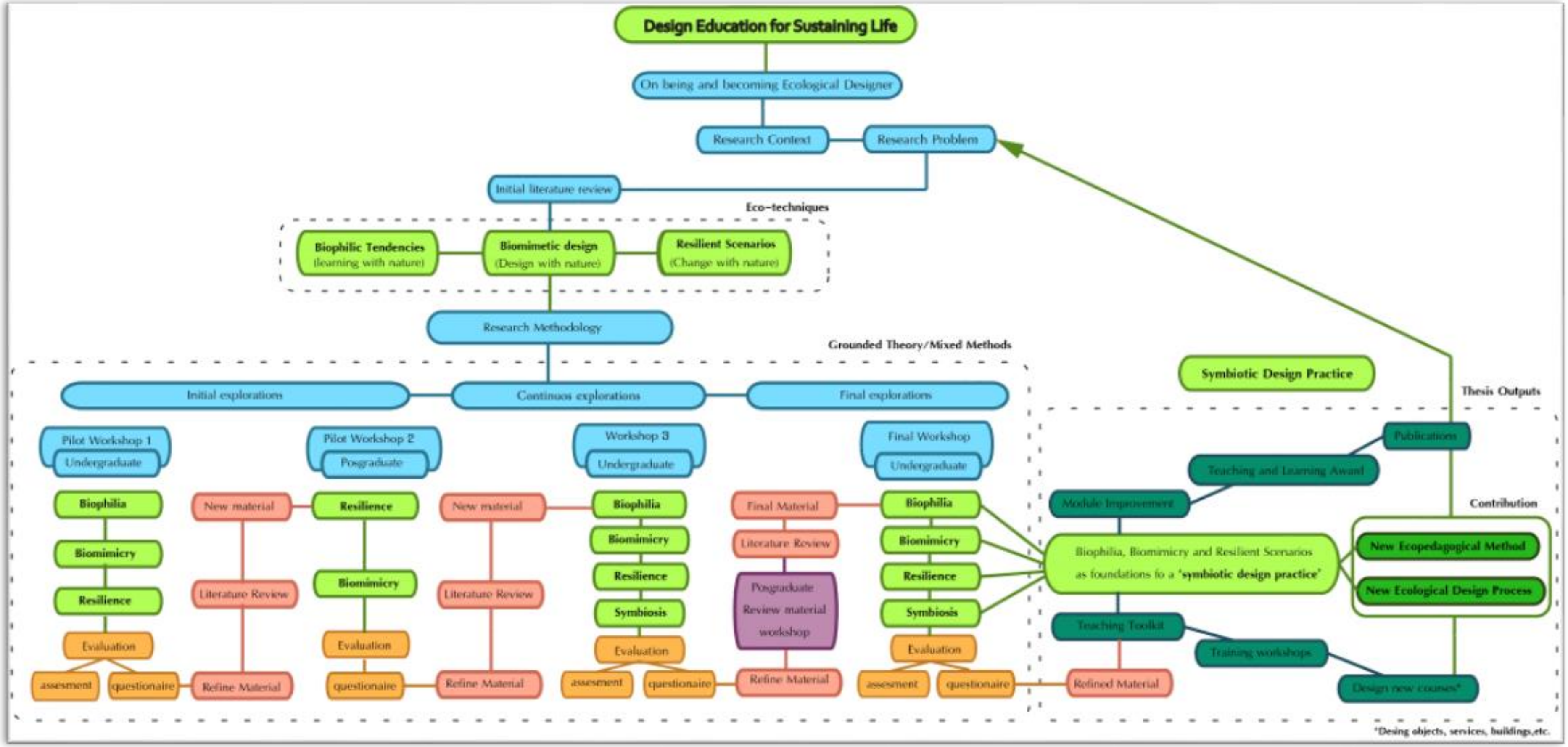

Figure 14. Research process (Action-Based)

Figure 14. Research process (Action-Based)

This diagram represents the iterations as seen/ found in an action-based cycle.

Action research helped to interpret the outcomes during each iteration of the workshops in order to build the *Symbiotic Design Practice* process and its foundations. Through action research cycles, the pedagogical framework was refined.

The use of mixed methods helped to formulate a more accurate and realistic understanding of the methodological approach. The literature review, a series of iterative workshops, and the development of new educational materials were the primary methods adopted during the action-based cycles.

Systematic Literature Review: This provided a platform to collect and synthesize high-quality research to critically respond to the research questions in a systematic way (Chalmers et al 2002). An initial literature review on ecotechniques helped to identify the philosophical foundations and to frame the pilot workshop content.
Furthermore, a continuous literature review during the data gathering and analysis of the workshops was fundamental in the building of a solid research foundation (See figure 15 below). The research goal was to review the 'why' and 'how' in the context of student learning for each of the ecotechniques and the *Symbiotic Design Practice* process (all of which will be discussed in the following chapters.)

Series of Workshops: The workshops offered a format within which to interact, learn together and explore the processes of design collaboratively. Here, the methods of observation, visual research and questionnaires helped the gathering of information required to refine the educational material and activities undertaken for the next iteration of the workshops (a form of prototyping testing). Pilot and formal workshops with undergraduates and postgraduates were then conducted.

Teaching Material Re-design: Analysing student questionnaires and deliverables, as well as the researcher's observations and field notes, helped to reframe the initial exercises and activities designed.

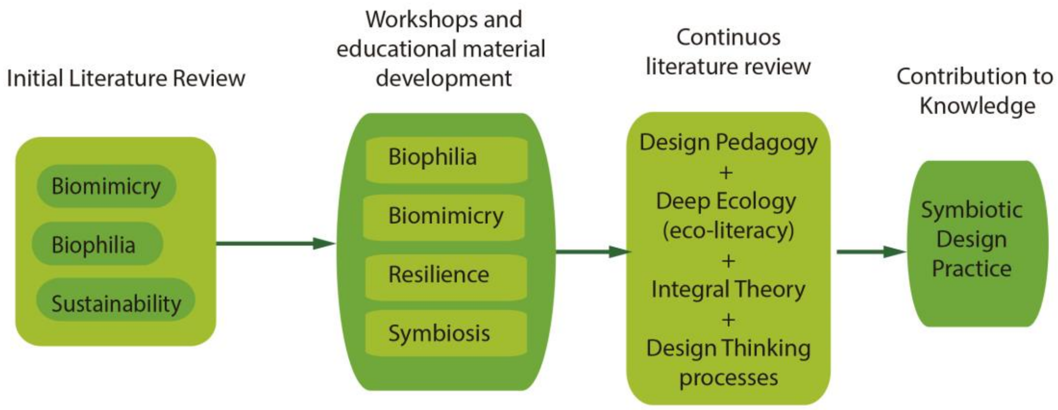

Figure 1515. Method rationale
The figure shows the process and methods used from the initial literature review on ecotechniques, to the design and development of the workshops, along with the continuous learning cycle of how the literature review reinforced the philosophical foundations, culminating in the development of the *Symbiotic Design Practice* (SDP).

Some of the constraints that directed the use of the following research methods include:

- Selection of participants. No free choice over the selection of participants. It was determined by number of students on each of the modules that year.
- No free choice to conduct workshops with postgraduate students, either in Masters at the university or at postgraduate events.
- Locations. Research place was limited at the beginning by the use of classrooms at the university and then change to different locations.
- Ethical methods of recording. The study was not imposed on student enjoyment of the module aims, the required content or delivery.
- The research did not cause any disruption during the explorations as it was embedded in a teaching style that included delivering workshops as part of a taught module and academic events that did not require any sensitive data. Questionnaires and observations were part of the research.

- Time. Restricted time available as it was dependent in only one module at the university and on opportunities in established postgraduate modules or events available.Another limitation was the planning of a final exhibition to collect more data. Collecting models, drawings and written articles to be displayed required time for planning, and a final exhibition was discarded.

Context: **"**Design Values Issues and Ethics" expansive module (DJ31014; Level 3; 30 Credits; Module leader: Jackie Malcolm; 20 Students)

Module description: This module aims to equip students with an understanding of the cultural and environmental issues that impact on design practice within the professional landscape (see Appendix A.3 for full description). This module has been introduced into the DJCAD strategy of expansive elective modules, thereby bringing together an interdisciplinary group of students from a range of disciplines (e.g. Product Design, Interaction Design, Graphic Design, Illustration, Environmental and Interior Design, Jewellery and Metal Design and Textile Design). This module is available to all Level 3 students studying design at DJCAD.

By using the UN Decade of Education for Sustainable Development 2005-2014's strategic goals for 'reforming education'(ESD-UNESCO, 2014), and The Higher Education Academy recommendations for sustainable development within HEIs (ESD HEI, 2009), the module formalizes and delivers these current and emerging issues within a design context to complement the core discipline studio modules delivered. These documents listed above help to frame the module aims in facilitating a holistic approach to theory and practice, thereby enhancing the learning experience of the students. Through this module, the value of design is recognized as improving the quality of life for humankind and the need for students to become aware of the relevance of environmental issues and ethical considerations as part of their creative practice. Integrating the series of workshops into this interdisciplinary module reflected the notion of designing for the real world. This module (unlike other expansive module offerings at DJCAD) adequately aligned to the fundamental aims of the initial plan to conduct this research study and was therefore the ideal module to build from.

During the initial pilot workshops, the findings from the literature review on eco-techniques indicated the use of already established educational material along with the new material which was subsequently tested and evaluated at the end of the module. The initial project brief was designed in such a way as to include the series of workshops on eco-techniques within the indicative content and the final deliverables and assessments of the module. After the submission of their final assessment, a questionnaire was implemented as a method of evaluating the student learning experience with the eco-techniques (later developed into the SDP). Drawing upon the qualitative feedback gathered from the students and module leader, as well as observational analysis and critical reflection by the researcher, the eco-techniques were later refined and improved for the following academic year (adopting an action-based learning cycle). In addition, the workshops were further informed by a continuous review of the academic literature and current practices.

The role of the researcher as facilitator was to work closely with the module leader in the delivery of all aspects of the module – project brief, individual and group tutorials, final assessment and review of final written feedback. However, the researcher was solely responsible for the design, delivery and evaluation of the eco-techniques used during the series of workshops.

2.3.3.1 Pilot Workshops: Research Methods

Briefing: The design of a project brief was an academic exercise written in collaboration with the module leader, which set out a challenge to be solved by the design students to assess their attainment of the learning outcomes. The brief also promoted the notion that students be given an understanding of ecoliteracy.[20] Some specifications for the design brief were as follows:

[20] Design briefs are also commonly used in consulting engagements, when an independent designer or a design agency executes a design on behalf of a client.

-To encompass within constraints of the timetable and viability of the final assessment.

-To foster an understanding of the principles of interdisciplinary teamwork. (Each team was composed of members from different disciplinary backgrounds, such as interior design, jewellery and metal design, graphic design, product design, digital interaction design, in variable numbers in order to activate their willingness to collaborate with others, while being confident of their own abilities, respecting the capabilities of others and working to complement the knowledge of others).

-To select a theme (i.e. health, housing, tools, transportation systems, food systems) for the final project and apply the use of eco-techniques in the application.

Learning Environment: An environment in which to learn is particularly important for the ecological designer. In this case, our classroom represented the world itself, not just the building. The use of the educational material and related exercises were interlinked with the educational facilities, and provided the integration of experiential learning and immersion in a natural environment. The Botanic Gardens at the University of Dundee and visits to the D'Arcy Thompson Natural History Museum were also inspiring locations that were selected.

Pedagogical Observations: During the series of workshops, observations were carried out on the use of the educational material developed and the participants' responses to the activities. Observation-based research is 'rarely a stand-alone technique. It offers guidance to initial observations and emphasizes things that can be seen and heard. It is also a well-established technique in educational research' (Arthur, 2012, p. 165). Therefore, the final presentation of assessments by the students, and informal conversations during the teaching sessions, were all part of the observational research conducted. Observation requires attentive looking and systematic recording (Hanington and Martin, 2012, p. 120). This kind of systematic observation and recording was linked to the structure of the series of workshops on each ecotechnique and by checking the aims of the module.

Observing the ways in which the students interacted in teams, worked with the educational material and experienced exercises outdoors, for example, became the basis for redesigning the activities and implementing them in the next series of workshops. The recording was through note-taking and reflections aligned to the ecotechnique that was taught. This kind of observation process is a topic defined as a *description of instructional processes* (Arthur, 2012, pp. 166–169), which helped to provide feedback to inform and improve the teaching of ecological design.

<u>Questionnaires:</u> As an instrument for collecting self-reports, various formats of questionnaires were used to collect information from the students after each session on a particular ecotechnique, and after the final assessment to evaluate the whole teaching module. All the wording, sequencing and layout referred to their learning process, feelings, perceptions and attitudes to see the world through an ecological and ethical lens. The results were not analyzed statistically but were used to reframe content and teaching materials to be used for the next action-based cycle. Questionnaires in this research study were used for two purposes: 1. To obtain feedback about teaching materials; and 2. To obtain outputs about the students' learning experience. The design of the questionnaires were reviewed by the module leader in order to remove any bias by the researcher.

The questionnaires were specifically designed for the collection of information to inform the design of better pedagogical outputs and structures (Hanington and Martin, 2012, p. 140,172). Questionnaires as a research instrument were designed in the following ways:

- Closed – forced choice, structured with limited response options
- Open – broad, with no set response to encourage discussion
- General – focused on the big picture, broad spectrum of issues
- Leading – to be avoided, suggest a correct or expected answer.
- Request for suggestions – invites participant to suggest new ideas, options.

The formats were various: open ended questions, short written responses, Likert-type responses and multiple choice (Arthur, 2012, pp. 231–239). For example, responses were captured using a version of the Likert Scale, using anchors such as 1 = strongly disagree; 2 = disagree; 3 = somewhat disagree and so on. The questionnaires were electronically based using 'Google forms' to collate the answers and for easy distribution. Paper-based questionnaires were administered after each workshop in order to evaluate the delivery of teaching material (theory and audio-visuals) and the exercises. Computer-based questionnaires at the end of the module helped to easily quantify the number of participants who answered the questions using pre-existing templates. There was no need for a scale of measurement, as it only required direct analysis to redesign activities and to continue with the literature review (See Appendix A.4 for example of an initial research questionnaire).

Discourse Analysis (only used for assessment stage with the students). The analysis of written discourses (Arthur, 2012, pp. 272–285), in this case the final reflective assessments, served as a way of identifying and capturing the use of the ecological lexicon – the ecological episteme – or in other words, the knowledge and values acquired by writing or omitting the ideas studied. Through these final assessments, the lexical items (particular words and phrases) identified were later incorporated into the idea of *Symbiotic Design*.

Analysing and assessing the success of the students' learning journey through critical reflective writing conformed to the notion of developing designers as 'reflective practitioners' (Schön, 1983), whilst also bringing together theory and practice. This also aligns to the experiential learning cycle (Kolb, 1983) by acting, reflecting, conceptualizing and applying to activities during the research and delivery of a design concept.

Visual research: Drawing (maps, diagrams, signs and symbols), taking a photograph and producing a video were other methods used to gather and analyze data by the students. This method also served as a tool to assess and interpret data by the researcher and the use of information tools by the student.

This kind of immediate visual text (Arthur, 2012, pp. 290–295) provided an interpretative process that could be transformative. Some of the visual pieces were 'self-reflection' by the students, in relation to theory and hands-on activities.

2.3.3.2 Workshops Improvement Methods

Continuous Systematic Review: As this research was developed in order to integrate a good pedagogical tool, constant systematic reviews – new publications such as books, academic papers, blogs and conference papers – were analyzed to complement teaching material and to reaffirm the foundational concepts of the SDP after each series of workshops.

Educational material improvement (refinement of teaching material): Based on the questionnaire analysis and observations in the classroom during the activities, some of the didactic tools and activities that were designed required improvement; some did not. The new materials were reapplied in the next series of workshops for both undergraduate and taught postgraduate workshops. In the following chapters and research exploration sections, the improvements are discussed in more detail.

Questionnaire refinement: After adding the necessary improvements to the workshops material, the questionnaires were also updated. In this way, questions were slightly modified or new questions added to respond to the new additions.

Context: Conference events and Master of Design for Services "Prototyping: Preproduction to Innovation" module (DJ52010; 20 Credits; Module Leader: Fraser Bruce; 15 students) and Master of Design Ethnography (extracurricular session with 9 students)

Conference Event: "Future Connections" was set up by a group of PhD research scholars at the University of St Andrews in 2012 to connect researchers with a shared interest in sustainable development. The annual conference encourages new and innovative ways of collaborative thinking and action in order to develop interdisciplinary and collaborative solutions to some of the complex global challenges we face.

Each year, PhD and post-doctoral students and early career researchers from a broad range of disciplines and institutions from around Scotland attend the event. By promoting improved communication and understanding of the current research being conducted in Scottish institutions, the conference encourages researchers to broaden their perspectives and promote future collaborations across different disciplines and institutions. The first Future Connections conference was held in St Andrews in June 2012 (Future connections, 2013). Since then, the conference has been organized and hosted by PhD students and early career researchers at the University of Edinburgh (2013), the University of Strathclyde (2014), and the University of Edinburgh (2015). In 2013, the author delivered a workshop entitled "Extreme Resilience: A way to change along with nature". This was an opportunity to explore and interconnect the concepts of Biomimicry and Resilience as eco-techniques through a series of visual presentations and activities whilst aligning to the main conference theme (which in this case followed the initial bio-synergistic methodological framework).

Master of Design for Services (Prototyping: Pre-production to Innovation module): Another workshop was conducted during the prototyping module on the Master of Design for Services programme.[21] This workshop was held as a 1-day session to explore ecological thinking as a way to prototype. In this session, the activities were designed thanks to the previously mentioned postgraduate conference. The focus was on the use of biomimicry and futuring techniques (e.g. forecasting, visioning and scenario-building) based on Resilience thinking.

[21] For more information on this module see: http://masterofdesignforservices.com and https://prototypingdesigndundee.wordpress.com

A more formal iteration of the workshops was held in order to explore the new materials (templates, activities and presentations) and to incorporate the findings discovered in the analysis of the systematic reviews. This implementation was re-structured with the new additions from the pilot postgraduate workshops. A new design brief and evaluative questionnaires were needed.

2.3.5.1 Formal Workshops 1: Research Methods

Briefing: The design brief reminded linked to the eco-techniques and was redeveloped in concert with the module leader. This time, the brief was more focused on a real world problem to be addressed by the design students (See Appendix A.5 for description). The brief was focused on the desired results according to the course outcomes (as previously explained in the pilot workshop section).

Learning Environment: The delivery of all aspects of the module was conducted at the Botanic Gardens at the University of Dundee in order to produce a completely immersive experience.

Continuous Pedagogical Observations: An emphasis in taking notes was undertaken during the sessions and paying attention to the usability of the educational material, the response to the activities and the participation between groups. The goal was to observe if the groups displayed similar behavior to the pilot workshop, especially toward the final assessment and the active participation of the students.

Critical Reflective Writing Analysis: This method was used to analyze the learning journey of the students as they moved toward becoming reflective practitioners through the eco-techniques. With the final assessment, the students had to demonstrate their capacity in displaying the use of the ecological lexicon through critical reflective writing that was later analyzed by the researcher and the lead teacher against the aims of the module and the design brief. In particular, the hand-in was in the form of a newspaper article which also represented what they learned from the workshops, bringing together information gathered through the course whilst communicating the complex information about ethics and ecology through their design concepts (See examples on appendix A.6).

Exhibition: As part of the final assessment, and taking advantage of the use of the exhibition space at the Dundee Botanic Gardens, a final exhibition was organized to showcase their projects to the public. The exhibition helped to direct conversations with the students in order to recognize the change of posture and mindset as individuals and as designers and take informative feedback for the researcher. This kind of exhibition exercise also encouraged the students' development through competitions or further implementation in final year projects.

Final Questionnaire Analysis: Evaluation of the workshops, as well as the module as a whole, was collected in the form of qualitative feedback via a module questionnaire provided by the university. This provided the students with an opportunity to also make constructive comments about the workshops.

An improvement workshop was implemented in a 1-day session with undergraduate students to explore the educational tools and practices used in the formal workshop. As part of the continuous learning cycle of iterating the series of workshops, 15 postgraduate students from the Master of Design for Services (10) and the Master of Design Ethnography (5) programmes attended a session in order to make recommendations on how best to improve the eco-techniques as an ecopedagogical tool.

The improvement workshop needed to be held in the same space used for the teaching (in this case the Dundee Botanic Gardens) to have an accurate input by the Masters students, which included the analysis of the learning environment. The goal was to help to evaluate the structure of activities and the readability/usability of the instructions for the exercises designed. In pairs, students discussed the educational material and also took part in some of the exercises as part of the session. The description and explanation of the material, in relation to the eco-techniques, was discussed and later implemented into the final formal workshops with the undergraduate cohort.

A final workshop was held as a conclusive iteration to use the methods and explore the improved educational material. This final exploration incorporated the new additions gathered previously from the postgraduate improvement workshops, pedagogical observations and final literature reviews. An evaluative questionnaire was again distributed to each participant.

2.3.7.1 Final Formal Workshops: Research Methods

Briefing: The design brief continued in the same format based on the previous formal workshops. The brief was also focused on the same desired results and according to the course outcomes.

Learning Atmosphere: The same location and inclusion of outdoor learning exercises were established.

Final educational material application: The templates and exercises were used with all of the recommended improvements.

Final Pedagogical Observation: During the sessions, final observations were made by the researcher in relation to the use of the educational material, the response to the activities, as well as participation between group members. This task was undertaken mainly to observe if the groups displayed similar behavior to those noted in previous workshops.

Reflective practice analysis: The assessment followed the same format; a newspaper article representing what the students had learned during the workshops and through a presentation of their final project. The exhibition of work was not implemented on this occasion.

Final Questionnaire analysis: The same dynamic for applying questionnaires to monitor the learning experience after every workshop session was implemented. The evaluation of the whole module provided feedback to analyze individual responses based on their learning experiences of the eco-techniques. This method of evaluation worked well to continually improve the teachings and the quality of the module.

2.4 Facilitating a symbiotic design practice: A meta-pedagogical outcome

In this case, the literature review analyzed, the activities designed, the construction of questionnaires and the analysis of final assessments, helped in the conformation and reconfiguration of the steps and stages for the *SDP* framework, as an ecopedagogical construct and the definition of *Symbiotic Design* itself. This new framework (integrating both theory and practice) was a systematic rearrangement through action-based learning cycles. It is envisaged that this new methodological framework will continue to evolve as it is put into practice by other design educators and by the researcher.

Teaching ecological wisdom through the use of eco-technics, as proposed in this thesis, requires a philosophical explanation, or going to the roots of every eco-technique and developing theoretical-practical explorations in ways that they interrelate in the formation of the *Symbiotic Design Practice* methodology. This can be interpreted as a meta-methodology. There is a fundamental need for design methods to improve the aims of their epistemology. Simply put, design needs to operate at a meta-level and formulate meta-methodologies to describe the indeterminacy (Buchanan, 1992) of any design intention. It is hoped that the methodology and methods described in this chapter act as a catalyst to support meta-methodologies as a human endeavour in developing wisdom (Maxwell, 2014).

Designers should be capable of integrating cross-disciplinary ways of working, to analyze the complexity of wholeness, and to be self-reflexive (Wahl and Baxter, 2008). Acknowledging the holism in design intention represents a reconstitution of all the living (Kossoff, 2011). This process of engaging with the bigger global problems, consciously, can be framed in a meta-methodology of ecological design, as developed through the following chapters. We need to find ways of teaching students how to question the ecological dimension of their concepts in order to develop wisdom.

Implementing such a meta-methodology into action (our ecoliteracy) is where the symbiotic designer will be able to unfold their intentions to design with-in nature. It is through experiencing, encountering, playing and visualizing, that the designer, with the help of the natural world, will reach this meta-level of self-reflection. For this researcher, the most important thing is not to identify a method of problem solving, but to experience the problem dynamically, visualizing it, being curious about it, playing with it, asking questions about it, discussing it, and seeing it through different lenses, prototype it, creating a blueprint, forecasting, and reflecting.

In the following 4 chapters, the procedures, the material, the literature and the philosophy behind every phase of the SDP process, is discussed in detail. This methodological approach can be interpreted as the original contribution to developing ecological wisdom, as it compiles the tools to reinterpret our symbiotic intentionality through design. In other words, to reconcile the human-nature paradox to develop the gifted holistic mind that every human-as-designer has within them.

Chapter 3. The Biophilic Being: Reconnecting creative minds with nature

3.1 Awakening biophilic minds: *Awareness stage (Divergent)*

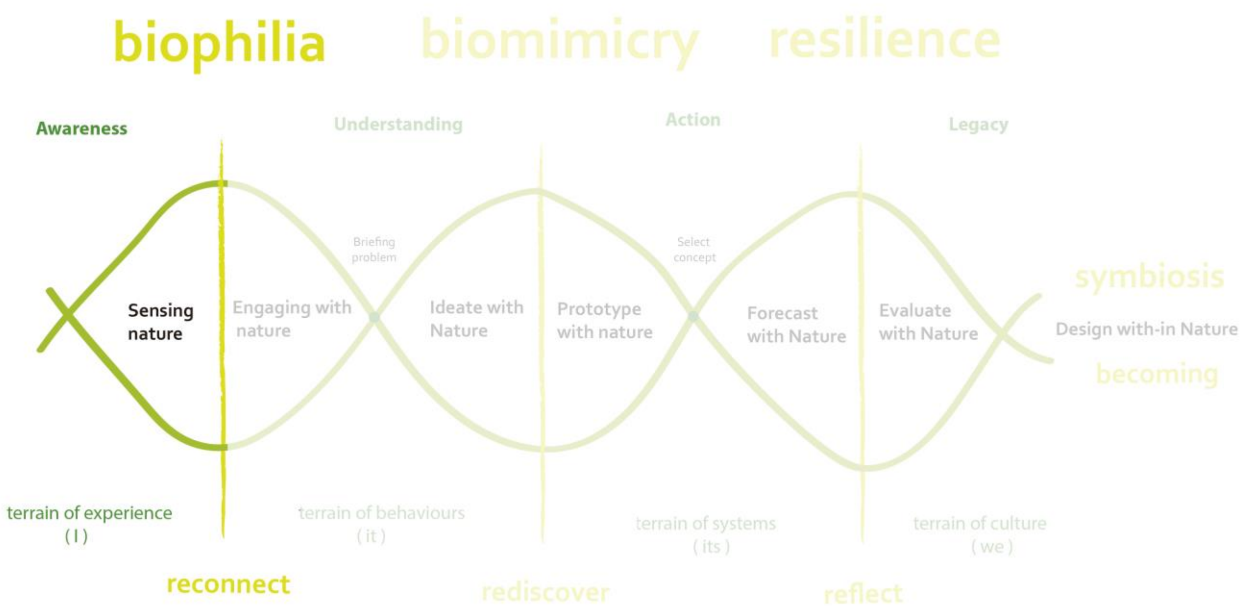

Figure 16. Biophilia Awareness Stage

The conscious reconnection with nature erases the boundaries of the so-called 'environment', shifting toward an empathetic and integral way of seeing ourselves as part of nature. On this first step of the SDP, we guide students to encounter experiences, but more importantly to cultivate consciously a process of encountering nature in everyday life, through their senses. It is through a process of encountering nature that new dimensions are revealed, that 'inspire and instruct' (Kellert and Wilson, 1995, p. 6). Sensing nature is a preparation step before one starts developing innovative ideas. It contains practices and theory that will help to ignite our ecological mind and prepare the designers to affiliate to what sometimes is invisible to the eye.

i. Introduction to Biophilia

As organic sentient beings, we are always unconsciously looking for physical, mental and spiritual well-being. We are constantly trying to cover such fundamental needs through designing new artefacts or systems that sooner or later will change or fail. Such failure perhaps lies in our perception of ourselves and what we do as something distant to nature. Such separation damages our intellectual capacity to participate, engage and, ultimately, become integral and conscious natural beings.

Imprinting deep symbolism as a result of our maladjusted worldview, Carl Jung (1968) argued an urgent need to rescue such *naturalistic* consciousness:

> *'As scientific understanding has grown, so our world has become dehumanised. Man feels himself isolated in the cosmos, because he is no longer involved in nature and has lost his emotional 'unconscious identity' with natural phenomena. These have slowly lost their symbolic implications [...] No voices now speak to man from stones, plants, and animals, nor does he speak to them believing they can hear. His contact with nature has gone, and with it has gone the profound emotional energy that this symbolic connection supplied'.*

This conceptual vision clearly resonates within the contemporary ecological thinking, yet also resonates with the whole education system, in order to begin the change to a divergent thinking, thereby transforming boundaries into an organic-system ethos. Healing our relationship with nature also comes through a balance between the unconscious and conscious ways of perceiving nature (Jung, 2002, p. 195). Thinking in our human culture tends to consider itself independent of what we call the 'environment' and this has damaged our moral values and psyche, by default, the way we design artefacts, services and cities. Even the separation between the arts and sciences has its roots in this problem.

Ecopsychological strategies might help us to restore our relationship with the world. When our psyche recovers the sensibility to appreciate nature, we can also enhance nature's psyche (Roszak et al., 1995, p. 98). The designers of the 21st century have the chance to stimulate the ecological psyche that is required to recognize the aesthetics, emotional attractions and the reverential qualities that Nature and all its complexities display. We are beginning to feel the need to reconnect with nature, to form of a 'biophilic society', one in which the love, spirituality, creativity and the belonging to a community of life is is evident. Therefore, by including the notion of biophilic practices, or in principle the biophilia concept, in the design epistemology, we can then fill the ethical gap of *being in nature*.

Biophilia, described by E.O Wilson (1990), is the 'innately *emotional affiliation* of human beings with other living organisms'. Wilson argues that, when we feel life around us with all its complexity and beauty, that is a real encounter. His ground-breaking publication describes how certain behaviors, such as gardening, keeping pets, hiking or watching documentaries, are clear signs of an emotional, yet evidently a genetic affiliation which demonstrates a strong, 'inherited' bond with our living planet. This concept was first mentioned by psychologist Erich Fromm in the 1950s. Fromm argued that a *love of life*, or love for living systems, is 'essential for human mental health and on that attachment we found is what is vital' (Fromm, 2011, p. 33).

Biophilia, translated from the Latin word *philia* meaning love, also stems from the same root as *phobia*, meaning aversion or fear. This kind of *biophobia*, felt as a negative emotion, can also help to acknowledge biophilia itself (Roszak et al., 1995, p. 4). Therefore, it is precisely this attraction, or repulsion that can keep us alive and inspires us to keep evolving, learning and, ultimately, creating with purpose. Indeed, avoiding danger or being open to the unknown natural world is what has made us human, and has enabled us to acquire our human senses, develop certain social behaviors and even create ethical structures that are intimately derived from our relationships with non-human others (Kellert and Wilson, 1995). These, and other features, define this biophilic attachment that can be temporarily ignored but never removed.

During the early 1990s, ecologists Stephen R. Kellert and E.O Wilson began to explore the notion of biophilia in human evolution and began developing a hypothesis (Kellert and Wilson, 1995). Furthermore, Kellert examined that beyond materiality, the passionate relationship with nature is manifested in our intellectual capacities, emotional bonding, aesthetic attraction and our physical and spiritual well-being; if we recognize such inclinations, we are more able to reframe our behavior and interaction with life, as a *bioculture* (Kellert, 2003, pp. 2–4). This kind of bioculture is when humanity aims to restore such a relationship with self-interest (Kellert, 2012, p. xi). More recently, Kellert added the notion of biophilic values – *attraction, reason, aversion, exploitation, affection, dominion, spirituality and symbolism* – that, on a biological basis, can explain such an affiliation with all the living (Kellert, 2012, p. xii). For Kellert, this kind of biological urge 'must be learned and developed to become fully functional; it is by experience and support for others that it will occur', and 'the ability to learn and reach the development of such values constitutes strength and weakness because it is not an infinite flexibility to learn them, is inherited' (Kellert, 2012, p. xiii). Therefore, it appears that we need to recognise a series of conditions in our everyday life; Kellet (2012, p. 188) also lists four conditions that are likely to occur when we encounter our biophilia:

1. 'Engaging all our biophilic values, each revealed in balanced relation to the others, and each in adaptive and functional fashion.'
2. 'Having a strong emotional connection to nature that reflects both a passion and a love of life and a universe of creation.'
3. 'Pursuing knowledge and understanding of the natural world recognizing the limits of our intellect and the need to apply this understanding with humility and restraint'.
4. 'Recognizing that ultimately the faith and reverent relation to the natural world will be necessary for us to flourish as individuals and as a species.'

Most of these conditions can then be recognized and taught. Feelings of mystery and discovery, the realization of physical healing and mental restoration, language and symbolic metaphors, the material skills and ethics, are an expression of our natural integrity and part of the matrix of our connections with the diversity of life. All these conditions can be reflected through design. The more we express our biophilia around us, the more we can feel part of life internally and externally.

This unborn affinity, that is latent in us as individuals, is sometimes earned through experiences as we grow up, but also can be cultivated. For example, as individuals, we can be immersed in an environment that provides all the pieces for acquiring a biophilic mind. Biophilic values can become 'dysfunctional' (ibid, p xiii). Being in little contact with nature can weaken these values, but also being emotionally apathetic or loving in excess, can cause adverse effects on individuals and society; this can carry irreversible harm to our human ingenuity and inventiveness.

Recently, Kellert (2011) and Beatley (2010) have also been promoting the notion of biophilic design and biophilic cities. For example, Kellert (2012, p. 158) argues that the paradigm of innovative design is related to 'ancient practices and principles'. Such principles are rooted in how we 'sense' the land we inhabit. The implementation of elements of biophilic designs not only embed the vernacular but the sensuous relationship with the more-than-human world.

So, the recognition of patterns, ecosystemic interactions or the potential of local materials, meaning and ethics emerge in the design of everyday life. The biophilia hypothesis and the movement of biophilic design, can accentuate design education and start to include efforts to guide individuals to comprehend their free will and instigate action toward biophilic values which can guide us to inhabit meaningfully, and reshape our ethical intentions. It is not only an individual but a collective interest to pursue fitness and fulfilment with such values.

To reconnect the biophilic self with the world is fundamental to alleviate the numbness of our senses. Our sensory systems are the ones that translate the language of nature. Some of them are altered, provoking a different path of our human response. Laura Sewall (cited in Roszak et al., 1995, pp. 201–215) calls for a reawakening of them by offering five perceptual practices or skills of ecological perception, which can help us to become biophilic beings.

We are here to sense the world first, then we can design. In order to affiliate with life, we need to teach and guide current and future generations into a self-discovery of sensorial capacities. To feel enlivened, we need experiences, we need to explore ourselves, we need to clear our senses and feel re-nurtured. The best way to approach design is to let our senses absorb or perceive our surroundings and follow our basic needs, and realize that our human instinct is a fact that makes us nature. Intuition is defined as direct knowing (Davis-Floyd and Arvidson, 2016). Physically, it differs from instinct, where the person is unconscious. Through intuition we are fully conscious; through intuition, we can have bodily, emotional, mental and spiritual responses (Miller, 2007, p. 90). The ecological designer seeks for the emotion (Goldsmith, 1996, p. 90) that is felt when we mutually engage with nature. We can see how important our capacity to link our emotional psyche is, our capacity to experience the interconnected self with all life, our biophilia.

ii. Encountering the natural self: Deep ecological awareness of design

This first phase of the SDP is about being more aware of ourselves and about understanding intentions we have toward our world. It is not only important to think of how design can solve problems, but to 'sense the rightness' of our human ingenuity. To experience this kind of rightness, first we need to feel our place in nature. For these reasons, what is needed is a design education where biophilic techniques bring the experiential and sensorial ways to design.

Although many papers and publications, from science to religion, have pointed to a wake-up call in how *we must be aware of our actions toward the world,* we continue in the same pattern. How can we address this complex cycle? Perhaps the answer lies in getting a taste of nature, or unlearning as 'rewilding ourselves' (Baxter, 2014). Unlearning is about going back to our roots, to our childhood, or to encounter the unknown as it was the first time. In other words, an awakening state that will make us confront our ecological consciousness to perceive as much as we can with all our bodily senses, in order to think intentionally to embrace and feel and integral part of nature and its beauty. Teaching a student to unlearn requires an effort and dedication to include radical practices that cultivate their emotions, intuition, interfaith, openness and, ultimately, to fully experience what it is to 'make sense' for the individual and for the living world. By approaching this unlearning attitude, we are more likely to change our behavior and transform ourselves and the world, gracefully.

The process of unlearning can be relatively fast. Going back to nature, and to reflecting in our intimate sensorial connections with the living world, is a process of rewilding (Olson, 2012) or reactivating our biophilic being. The following personal story expands on this concept:

> It was in May 2010, on a field trip organized as part of a practical module that I taught at the National Autonomous University of Mexico (UNAM). This module, entitled

“biomimetics workshop” (Taller de Biomimetica), was a serial module part of the Masters programme in Industrial Design. The previous module was a theoretical one called Biomimicry and Holistic Design (Biomimetica y Diseno Holistico), in which philosophies behind Ecological Design and Biophilia notions were taught. One of the activities was to take the cohort for three days of fieldwork research at “Los Tuxtlas” Tropical Biology Station (Estacion Tropical Los Tuxtlas), located in the State of Veracruz, South Mexico.

As it was my first time there, I only had the information provided by the administrators about the facilities to be used and explored. My plan to conduct this field trip was mainly to spend the days ‘immersed’ in the jungle. At this stage, I was unaware of the number of experiences that the students and I were going to encounter during these days. A sense of curiosity, a sense of discovery and a sense of awe were developing without awareness to us.

The main aim was to explore, open the senses to nature, use some of the methods already taught, enjoy the location and get back to the classroom full of ideas, sketches and, hopefully, a more relaxed atmosphere. All these aims were fulfilled. Nevertheless, I discovered something special changing in myself and in the students as we walked through the station.

On the first day, after a short guided tour of the facilities, the administrators gave us the freedom to explore but with precautions to stay together and follow the signs of the jungle paths. My schedule was simple and encouraged the same freedom, inviting students to open their eyes and look closer at the details more closely.

Equipped with magnifiers, sketch books and mosquito repellent, we all felt ready to adventure, to encounter. The first night was hard, as the noise of the jungle increased outside our dorms. Moths, mites and rain welcomed us. On the following day, the Goethean method was used and discussed. After that, there was no agenda but to keep exploring and “feeling the space” we where in. After that, I realized that the students and myself entered into a state of trance or ecstasy with that freedom. All were happy, careful, sensible and respectful of our surroundings. The jungle was our classroom. The animals and plants their teacher.

All the unexpected events that took place will always be remembered. From encounters with insects, lizards, toucans and howling monkeys, to unscheduled visits to climb

> mountains, swim in the mangroves, jump in waterfalls and navigate in the lagoons around us. Over that period, the didactic resources were used as expected and the cohort felt fulfilled with all that they had discovered, but at the same time they were astonished and perplexed with all that we learned just by being aware of the design of nature. Finally, I concluded that it was not a workshop on biomimicry but a workshop on biophilia, yet also that I knew nothing about experiential learning.

This story provides the context for the importance of students being aware of themselves 'in' nature. This kind of awareness in our times can only be achieved with practices and theories that are more related to unlearning the wrong and shallow paths that our society has taken. Before generating ideas or designing dangerous or useless artefacts, we must be aware, not only of the impacts we have caused, but also the experiences we frequently have. We need to awaken our biophilic consciousness.

This kind of consciousness is perhaps linked to a new sensitivity. Orr (2004b, p. 109) examines how we urgently require a modification in the skills, aptitudes, abilities and curriculum as we learn to foster 'ecological design intelligence'. Such intelligence requires us to:

1. 'Equip students with a basic understanding of systems and to develop habits of mind that seek out "patterns that connect" human and natural systems'.
2. 'Teach students the analytical skills necessary for thinking accurately about cause and effect'.
3. 'Provide students with the practical competence necessary to solve local problems'.
4. 'Teach students the habit of rolling up their sleeves and getting down to work'.

Along with these four fundamental aspects, we can consider adding an extra task, one that will lead to students' to expand their interest in acquiring such intelligence. This involves <u>guiding the students to encounter nature</u>. With this task, it may be possible to advance the development of the biophilic being.

The joy and meaning of life when encountering nature is enhanced through increased self-realization, which implies a broadening and deepening of the self (Seed, 1988, p. 20). In this case, the individual designer needs to develop not only creative solutions but to promote care, respect, responsibility and love in a wide sense, thereby expressing the sense of being with the self and the self *with-in* the world, the *ecoself.* This kind of self-love and purpose widens our capabilities to develop biophilic designs. To achieve such a biophilic ethic, we firstly need to build it into ourselves, not in our policies or actions. Russell (1982, pp. 129–143) expressed how we need to realize our essential 'oneness with Nature', not just with our intellect and reason, but with our feelings and with our souls.

Learning and encountering nature draws our attention to the following biophilic question: What would nature permit us to do here? This also rises deeper questions directed at other living beings: What are you? How can we live here together in this place? The shift to these inquiries opens possibilities to change our behavior toward more biophilic ways. It becomes clear that we need to expand our wisdom and prepare generations to ask 'deeper questions' (Devall and Sessions, 1987, p. 74) that touch on cosmogony, to feel a 'sense of belonging' to a bigger self.

In ecosophy, the concept of the 'self' expands to include the web of life, where each individual expression within the web is also valued (Sessions, 1995, p. 81). For example, our living nature, including entities such as mountains, rivers and entire ecosystems, represents how we can see ourselves integrated and coping with a larger whole, but also see inside ourselves to act accordingly to a larger whole. In psychological terms, there is a c*ognitive structure* (Capra, 2002) that can lead us to reach a level of consciousness in what we experience about external phenomena and internalize what we are in the world. This kind of ecological shift has been represented as the quest to recognize the Earth as a living being. Such cosmogony is currently represented s in the idea of *Gaia* or Living Earth, (derived from the appreciation of the Greek Goddess Earth). Gaia theory, developed by Lovelock (1979) and further expanded by Lynn Margulis (1991), has been driving the human intellect to find ways to associate with the complexity of all the kingdoms of life and its symbiotic evolutionary patterns. This association or symbiosis with other life forms, and with the Earth, represents an incentive when encountering nature and encourage us to respond accordingly with the process of biophilia.

By entering into this deep ecology domain, designers are able to focus on a deeper level of self-awareness, being aware of when we act and, that by changing the environment, we change ourselves. As we begin to rediscover Gaia's intelligence, we also begin to activate our senses. This Gaian strategy has its roots in the study of holistic science and deep ecology. Harding (2009, p. 41) uses a 'Jungian Mandala' to explain the process of *intuition, sensing, thinking and feeling as ways* of knowing. According to Harding, thinking 'interprets our logical rational ways, feeling evaluates negative or positivity valuing phenomena'. On the other hand, using our senses and intuition 'helps us to perceive and makes us aware without interpretation or evaluation'. A Gaian approach can, therefore, help in the stimulation of the biophilic being, balancing the conscious and the unconscious as 'in' the bigger self. It is to learn what the Earth (Gaia) is telling us.

To achieve this, Harding uses Goethean science to ignite an active introspection of ourselves and what is outside, or 'sensing of the whole'. In his view, this deep ecology approach helps us to have a deeper experience, that will lead to a deep questioning and a deep ethical commitment that will allow the right action to take place(2009, p. 274). These deep ways of knowing can help to achieve our ecosophy or ecological wisdom, as Naess identified (cited in Harding, 2009, p. 57).

This kind of Gaian framework, or cognition as Capra espouses, is difficult to accept because it runs counter to our everyday intuition and experience (Capra, 1997, p. 278) . Thus, being aware of what nature is telling us or trying to communicate, we need to expand our perceptions and emotions, and to activate our biophilic intuition to begin to think and design, mindfully. When we are aware of our immediate context, we are more likely to be open to sense the natural patterns and what nature's designs mean. Here, human imagination transcends the intrapersonal intelligence to an interpersonal-biophilic intelligence.

If we go back through our history, we can find traces of the way in which ancient civilizations used to be in close relationship with animals, plants and immediate ecosystems. Their intuition, morality, spirituality, imagination and creativity were implicitly influenced by the patterns found in nature. Their language, clothing and many technical developments were shaped by the direct interaction with nature. Presently, we can still find indigenous communities all over the world preserving exceptional worldviews, giving, for example, a 'personhood to mountain range' or 'interpreting the language of other species' (Nelson, 2008). Practices, such as the use of psychedelic plants, dances and clothing mimicking animals and different kinds of worship and actions toward particular places, no longer represent the guidance and intrinsic sacred awareness that can be found in the 'wild'. This kind of sensitivity, or openness, to *feel connected to nature* is a clear manifestation of biophilia, which shapes our human purpose.

Therefore, developing a biophilic mind enables us to stimulate our sense of coherence within the world, and encourages the collective and individual unconscious to understand the notions of regeneration, environmental policies and ecological design. Animal shelters, coral reef restoration, urban farming, natural reserves and even ethnographic reconciliation, are a few examples of how our biophilic sense is starting to permeate into the design academy and into our socio-ecological mindset. Intentions, such as catching rainwater, growing food locally or crafting zero waste, illustrate that human are becoming mindful to of facilitating biophilic designs for the well-being of bees, mangroves, sea creatures and entire ecosystems (See Figure 17 below).

Revealing our unconscious cognition toward the non-human world may require an effort beyond this thesis, probably in the fields of ecopsychology and other behavioral aspects of education that are not covered here. The following sections facilitate how sensing nature allows *reconnection with nature*, in other words empathize with the non-human world with our senses, helping to find the biophilic being in the designer.

Figure 17. Images of biophilic tendencies
From top: 1. Indoor garden, Atocha station (Spain, El Pais 2010) 2. Keeping pets, Petr and Minsk at work (Huffington Post, 2012) 3. Biodiversity bridge Netherlands (unknown photographer, 2011) 4. Reef restoration in Bali (Biorock Tech,2010)

3.1.1 Empathy with nature: An unconscious affiliation

As we grow up, our senses absorb all the information of what means nature. This information is dictated through the places we inhabit, the climate, the seasons, the animals, the trees, and not only by our human interactions. We, as individuals, unconsciously 'experience' the world, which is precisely one of the key aspects of our empathy with nature. Being in close contact with nature is what makes us human and also makes us creative creatures. Empathy with nature is to experience biophilia and its value. The design academy must consciously create the routes of empathy with nature, not just by facilitating the theory, but by implementing teachings that foster the experiential relationship with nature.

In one way or another, the design academy implements experiential learning in order to develop creative skills (Christiaans and Venselaar, 2005) (Beckman and Barry, 2007). Nevertheless, our senses are numb, biased by the requirements of the economic consumer-centred culture. This numbness causes us to perceive nature and ourselves in a myopic way. For example, some undergraduate programmes must adapt to the needs that an industry claims, without paying attention to individuals' experiential ways of living and learning from the natural context.

Experience is defined as the 'apprehension of an object, thought or emotion through the senses or mind' (Dictionaries, 2010). Experience is constructed by subjective consciousness, but can change to an objective self-awareness (Borden and Collins, 2014, p. 70). In fact, by consciously acknowledging our bodily senses, we can gain experience in any act, including designing. It is argued that awakening our aesthetic senses and our compassion about nature ignites our imagination (Borden and Collins, 2014, p. 334). Designing requires us to access deeper levels of awareness. Here, our biophilic senses are key.

Some higher educational institutions (HEIs) have developed their design pedagogy beliefs toward the experiential catharsis. They guide their students to have beautiful experiences immersed in nature and, in turn, this helps students to think beautifully. Many other design institutions must attempt to incorporate this way of working on such in similarly cathartic encounters. The designer will therefore create beauty, but to achieve this openness, we must guide and support students in losing their fear of the unknown and being ready to receive information that will transform their ways to seeing nature and being in nature. It is by seeing nature with other eyes or in the shoes of another non-human being that we will find the way to understand ecological principles that will guide us to a biophilic society. As we begin to understand the language of nature, we become empathetic, accepting that the life of other species are different but that it also connects with our human way of life.

Having direct learning experience with nature is difficult. Indeed, we are constantly distracted by our technological commodities and accelerated lifestyle. To some extent, the way design is taught in some education institutions becomes an exercise of randomness and triviality. The consequences are in how we will continue on the same path, losing connections with nature. Restoring our biophilic minds will require a change from the inside of our design education institutions to the implementation of, and new radical practices, that stimulate individuals to <u>value what they are in nature and what they want to design as nature</u>.

Design educators could emphasize the importance of biophilia by looking beyond ecological trivialities in material extraction, or the use of a building or an artefact just for human purpose. Indeed, teachers who promote learning outdoors by interacting with plants/animals in the classroom, organize field trips to natural areas, zoos, botanical gardens or animal rescue centres, or promote projects for restoration of environments are more likely to develop the requirements for biophilic values (Malcolm and Sanchez Ruano, 2015). These new ways of working can emotionally and socially engage our way of promoting ecological design.

Van Der Ryn (Ryn, 2013, p. 8) distinguishes that empathy is 'learned and practiced through direct experiences and awareness that there is life beyond the physical, material world'. His approach to understanding our genetic need is to connect to nature through regenerative projects giving the chance to self-heal, self-organize and self-evolve, rescuing the inner sense of unity with nature. He also recognizes that promoting practices like gardening, yoga, psychedelic experiences, painting, time in solitude, connection with others and being grateful for the gift of life itself can provide the empathy needed in the designer, and, ultimately, the self. The philosophy of biophilia, along with practices that invite individuals to rediscover nature, can help not only to foster kindness and empathy with the non-human world, but with ourselves to become instruments of ethical change through design.

Nature, as an abstract concept,is difficult to teach or define in words. Drawing upon biophilic practices, Hutchins (2014) defines it as 'the omnipresence flowing through all of creation – all-pervasiveness'. If we link this definition with the concept of consciousness, it represents the capacity to be aware of ourselves (body and mind) and connect with the real context we are living in. Appreciating the place we inhabit can help us to focus our enjoyment and attention, a 'felt relationship' (Cooper, 2012, p. 111) that keeps our memories connected to our senses, which are ever receptive to natural designs. This engagement with nature can gradually help the individual toward an 'inner transformation' (Cooper, 2012, pp. 112–113); the person or student will be no longer the same. The acquisition of a biopilic worldview is then likely to emerge.

Activities identified as stimulative biophilic practices are those which can help us to be aware of nature and be readily conscious to *sense nature*. These activities can be described as 'immersive' exercises, used to achieve a *sense of place* and the *sense of self* within nature.

3.1.1.1 Stimulative biophilic practices

a. The use of the Natural Classroom

It is only by being in remote spaces outdoors or in related urban facilities (e.g. Botanic Garden, city park), that we can feel and experience the 'presence' of nature and be able to 'tune into' ourselves. Hutchins (2014) describes how, as we attune with nature, we attune with our own unconscious in allowing it to become conscious. Hutchins refers to Peter Senge and Otto Scharmer from *The Presencing Institute* to define the act of 'presencing' as: to sense, tune in and act from one's highest future potential. *Presencing* blends the words 'presence' and 'sensing' and works through seeing from our deepest source (Presencing Institute, 2014). This act of presence and sensing is what phenomenologists like Heidegger and Merleau-Ponty have explored in detail (Existential Phenomenology, n.d.). Hutchins (2014) relies on this presencing, or 'meditation' to illustrate the way in which we allow our ego-boundaries to encounter nature in the present and adapt previous experiences as an empathic resonance. Being literally 'in the zone' to encounter nature is then to be open to experience our true nature.

These kind of harmonizations or stimulations, developed through explorations of meditational and playful exercises with the senses, help to immerse one in an outdoor space. According with the holistic curriculum, meditation/centring practices involve the quieting and focusing of the mind to activate our ecological self and allowing the senses and consciousness to go beyond relaxation, 'enhancing our natural creative capacities' (Miller, 2007, p. 179).

Being immersed in an unspoiled space or a contemplative landscape – a forest, beach or meadow – is ideal to develop these practices. This action can lead us to encounter nature vividly and to enter into a state of curiosity and wonder. When teaching biology, ecology, sustainability and related environmental science, it is a fundamental practice, for example, to study ecotones or species interaction by observing them their natural habitat. Unfortunately, many design academics do not include outdoor immersion practices, unless it is for drawing, art or landscaping practice.

Therefore, outdoor spaces are a keystone to developing the biophilic being. For example, E.O Wilson realized this whilst studying ants in the Amazon rainforest. This indicates that botanic gardens, outdoor education parks or other kind of inspirational countryside spaces can be a good resource that can help to plan experiential biophilic practices. Thus, being away from the conventional classroom is the first action to take into account. Teaching outdoors is an ecopedagogy; some insights of the benefits of being in close contact with a natural space are to:

- Respond to emotional learning, develop a sense of place (Wood, 2011, p. 48).
- Take sustainable-based approaches, provide a nurturing environment and develop creative capacities (Robertson, 2014, p. 9).
- Maximize the learning experience (Hammerman et al., 2000, p. 1).
- Encourage Ecoliteracy (Orr, 1991).

Experiential and reflective learning are well known in pedagogy (Moon, 2004). Having experiences, reflecting on the experience, learning from the experience and finally trying out what we have learned, is the cycle of experiential learning (Kolb, 1983). Adapting this cycle at the awareness stage implies acquiring knowledge to become aware of nature through the implementation of exercises, to engage with nature (feeling), to then link those experiences in the design process (doing) and finally, reflect on the learning journey (thinking).

In today's academic life, teaching designers in classrooms without natural light, without views to the outside and far from green spaces, restricts the semi-permeability of their ego. This results in the formation of designers that repeat the same kind of fragmented designs and human-centeredness.

The following activity is an example that helps to develop an immersive biophilic practice in a natural classroom. This activity is the first one of many included in the SDP process. As the others, it includes activity instructions for the teacher or facilitator and sometimes narrative instructions to be read for the participants. Research explorations are given at the end of the activity as a way of reflection. Each activity invites the design educator to open possibilities to design their own.

Activity 1. Immersion

Step 1. Choosing a Natural Classroom

Activity Instructions: Identify a local space with immersive natural characteristics such as: lots of trees, plants, animals, water bodies preferably isolated from urban noise. Facilities such as botanic gardens, parks, biological stations, nature reserves or any other place with outdoor-related access can be used to conduct the teachings and most of the following activities. We must keep in mind how the space needs to offer natural light and ventilation.

Step 2. Biophilia Theory in Place

Activity Instructions: Once installed in the place, and with the required classroom amenities (flipboards, projectors, furniture, natural light and ventilation), facilitating lectures containing the theory of Biophilia and Gaia Theory are fundamental to be introduced. Expressing examples of biophilic values and displaying content related to these themes on site becomes more appealing and easy to grasp for the students.

Step 3. Audio-visual biophilia

Activity Instructions: From your own selection of nature videos or documentaries (see Appendix B.1 for examples), select or edit a 10-15 minute clip in which nature is displayed in all its splendour, representing the living biosphere (i.e animals, rainforest, reefs, waterfalls, birds, etc). Beyond the aesthetics, this should represent a poetical way to find an inner connection with nature. After the video, the teacher or facilitator will ask the students a key question in order to remember their affiliation with a living organism (see narrative instruction below). After that, encourage them to individually share which organism is their favourite and why.

Narrative Instructions (for participants): Take a minute to think of your favourite organism (animal, plant, bacteria, fungi or ecosystem) and ask yourself why? You can draw it, make notes or even share a story or curious facts with your peers.

See the Research Explorations (3.1.a) on this activity.

b. Sensing the place: Activating our senses

Our senses are the key to design. Creative individuals need to rediscover their own capacities to perceive. Reconnecting with nature is to reconnect our senses, this means that trusting our senses is trusting ourselves. By being conscious of ourselves, we become aware that the place we live in reveals who we are, through our senses. Engaging with the natural world, and our immediate environment, involves the feelings and emotions that are connected with our body and mind. Teaching future generations to belong to the Earth is urgent, as we are losing meaning as our urbanization, high mobility and consumerism is increasing. For this reason, articulating ways of belonging to a place is a fundamental feature of nurturing through design.

In his writings, Arne Naess discusses how strengthening a 'sense of place' reinvigorates the internal relation of the self to the environment (Drengson, 2005, p. 339). Regarding the exploration of a sense of place, outdoor educator Richard Louv identifies a problem: 'We cannot protect something we do not love, we cannot love what we do not know and we cannot know what we do not see, or hear, or sense'. He also points out that we have lost the connection with our natural history and how important it is to recognize where we come from (Louv, 2012), this is essential for our souls.

Inspired by Wendell Berry's observation that 'you can't know who you are until you know where you are', and by the growing disconnect between our human culture and the natural world it overlies, Harwell and Reynolds (2006, p. 7) created a practice to develop *rootedness in place,* through their programme 'Exploring a Sense of Place' (ESP). Drawing upon their works, we can see how fundamental finding the self is in relation to the place; this highlights the importance of knowing where we belong, in other words being indigenous to a place. Our senses are attuned to the context. Our sensorial capacities, for example, are rooted in the stimulus we develop during childhood and its wider context.

All our senses are important together. But if we compare our senses with the senses of other animals, or even plants, we notice that some of their senses are more stimulated than others; odor or touch are more important in animals than sight is in humans. This means that in order to go beyond the visual sense, we need to learn to use our bodies to fully experience nature and to attune the senses. Our senses are the most vital resource to understanding color, proportion, sound and flavours and, ultimately, our awareness about the information sensed about the whole. This *gestalt* needs to be developed freely by the individual, and with a bit of help in the early stages of our lives, as Pestalozzi suggested (cited in Erikson, 1991, p. 31). Being conscious of our senses is to keep us grounded within ourselves (Erikson, 1991, p. 36). Thus, through developing a sense of wonder, awe and reverence with our senses, we can achieve biophilia, and by doing so we prepare our senses to design mindfully.

Csikszentmihalyi (1994) describes that our ancestors have switched time and again from trusting their minds to trusting their senses. He quotes sociologist Petrim Sorokin, who described how we are able to alternate between the 'ideational or value ruled phases', and the 'sensate', or pleasure rule phases. Although Nature's evolutionary rules allow us to experience pleasure, we understand how to balance this pleasure of being immersed in a place we sense consciously. This kind of elevated sensitivity is the reason we perceive everything with our emotional body. When we receive impulses or frequencies, we react gently or against them. The normal frequency that humans had before domestication alters to suit the exploration and enjoyment of modern life; 'we are tuned to love. As children we cannot define love as an abstract thing, we just live it' (Ruiz, 1999). Therefore, practicing exercises that involve a sense of place must be developed to assemble the senses in order to incorporate an emotional bond with the local context that we are experiencing.

Abram examines how our relationship with the world around us, through our sensorial bonds, associates with truth, responding to the logos of the land (Abram, 1997, pp. 264–68). Our stories with the world need to make sense or, in other words, *enliven the senses.* He also identifies that there is an intimate reciprocity to the senses; as we touch the bark of a tree, we feel the tree touching us; as we lend our ears to the local sounds and ally our nose to the seasonal scent, the terrain gradually tunes us in, in turn entering in 'sensorial present' (Abram, 1997, p. 272).

Our bodies are here to receive and be stimulated by nature. As soon as we begin to pay attention to the place through our senses, we begin nurturing our sense of wonder. E.O

Wilson (1990, p. 10) describes how our sense of wonder grows when we look to explore the mysteries of nature, that it is something in us, an inborn human trait.
From a design perspective, if we go back in history to medieval times, objects were less prevalent and for that reason held more significance (e.g. a carved stone had a sacred or magical meaning). In the present day, everything seems digitized and with a lack of significance. Life contains less wonder because we are incapable of perceiving the links with our natural energy and matter. Our senses may become muted or numbed by the frenetic way of consuming-producing-consuming. This is an aspect that designers now need to reconsider as a matter of urgency.

Everything in this world invites us to be mindful and to participate with our bodily senses (Abram, 1997, p. 47). Every texture, every sound and every flavour is telling us how to engage with the world. Abram identified how, only by affirming the *animateness* of perceived things, do we allow our words to emerge directly from the depths of our ongoing reciprocity with the world. For example, materials, such as the alloy metal of a car, the clay on the brick of a building or the wood of a chair, have an abstract sensorial dimension crossing within our body. From his phenomenological approach, Abram defines how 'we are organs of this world, flesh of its flesh, and that the world is perceiving itself though us' (Abram, 1997, p. 68).

Another point that Merleau-Ponty distinguishes is that 'our language is the very voice of the trees, the waves, and the forests' (cited in Abram, 1997, p. 86); we express what we perceive. Rediscovering our sensuous affiliation with plants, animals or minerals is a yearning for biophilia. We are losing more and more animateness, but there is still hope to reconnect to our senses, unlearning what we have done, and relearning to use them again. Animating our senses, by meditating in the present moment, is to learn to listen to the rivers, birds and trees, and understand that they have their own ways to communicating with us. This will make us biophilic, sensitive beings.

Therefore, to truly become a 'biophilic civilization', we need to start perceiving. This kind of *anagnorisis*, or 'sudden awareness of a real context of discovery' (Dictionaries, 2010), implies how we mindful we are. Meditational practices raise questions related to the education system and how we are training individuals to be aware of themselves and the stories we are making of this world, through designing. From a design perspective, we need to learn how to make sense, to be truthful and mindful with the world, before starting the design process. Only when we feel sure of what is really surrounding us, can we become engaged with our eco-selves and be able to respond mindfully to what the world is telling us.

Using the same instincts, animals and plants are connected to a certain place and climate, their senses help them to settle down, to move certain distances and to perceive danger; they are aware of their place. Sometimes, senses are highly sensitive to one single stimulus. For example, when we change from an urban environment to the countryside, we may be hyper-stimulated with information.

Based on the 'sense of place' premise, the following activity is a sensing exercise inspired by a visit to the rainforest at Los Tuxtlas, Mexico (See p.83) and a short course taken at Findhorn College in Scotland on Biomimicry for Educators.[22] On my visit to Los Tuxtlas, the experience of being immersed in a natural place was observed, and being out of the conventional classroom was vital to encountering our biophilic being. In the Biomimicry course, a technique was found that encouraged the awareness that our senses must be linked to 'feel the place we are going to learn from'. Central to this exercise was the introduction to mindfulness sensory activities, developed and led by PhD scholar Kumanga Andrahennadi as part of her Mindful Design Practice (MDP) framework[23] (Andrahennadi, 2014), on the module for Service Design at DJCAD,[24] and where the researcher was a participant. Through the invitation to participate in the MDP module, the researcher was first introduced to mindfulness practices. These practices were specifically focused on the senses, and the perception of nature this also was of great interest to this researcher. The seeing, hearing, touching, smelling and tasting that was involved in the MDP framework, were experienced in a different way. The practice of tasting, smelling and hearing were integrated within this thesis as these were deeply, and in this case mindfully experienced. Witnessing how Andrahennadi delivered her MDP

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[22] For more see http://biomimicry.net/galleries/2012/biomimicry-educator-training-in-scotland/

[23] For information on Mindful Design Practice see: https://www.youtube.com/watch?v=iPhGXlQRLnw and Glossary: Mindful Design Practice: A brief introduction by Andrahennadi (2013)

[24] For more information on the MDP module at Service Design Programme see: https://masterofdesignforservices.com/study-info/modules/mindful-design-practice-2/

framework, and how she explained mindfulness, was fundamental to making the connection with previous exercises experienced and taught by this researcher.
The following activity is an example of how to integrate the sensorial foundations of the *Symbiotic Design Practice* and the preparation stage focused on biophilia.

Activity 2. Sensing

Step 1. Activating our senses to become one with nature

Location: Green spot with trees (outdoors)
Time: 10 - 15 minutes
Resources: comfortable clothes

Activity Description: This is a step where the facilitator guides the students to become aware of the senses, by scanning the environment. Conduct the students to a previously selected green spot where the entire cohort can gather in a semi-circle and feel comfortable standing. The location could be a cleared area under trees or meadow preferably.

Being in the place and whatever the weather, invite the group to relax their senses and feel immersed in the place. A quiet area will help the facilitator to relax the voice, to give clear narrative instructions at a smooth pace (read below).

Narrative Instruction: By closing your eyes, you will be ready to scan your surroundings using your senses. Let us feel the place that will be our classroom. Let us start with the sense of smell (jump to the next narrative instruction of step 2).

Step 2. Smelling

Activity Description: The sense of smell is important for us to identify the presence of other beings, healthy food, dangerous substances, or weather. In direct connection with the neutral smell of the air, the students will be able to explore this sense by reacting against the information that the scents around us provide about the place and other presences.

Narrative Instructions: (continue with eyes closed) Focused on your sense of smell, I will invite you to breathe deeply, inhaling and exhaling three times. Now I will invite you to smell the essence of the trees around you... the flowers... the soil under your feet... inhale, exhale... focus on any smell that reaches you... where is this smell coming from? Why is it in the air? How has it been released? What is its function in this place? What is its function in our organism?...Just think about those questions.

Step 3. Hearing

Activity description: The sense of hearing is important for communication. The wide variety of sounds differs for each individual. In the animal kingdom, those differences matter as danger, food, sex or joy fluctuates. Certain noises, such as streams, waterfalls, sea and wind, can give us pleasure; even silence is important to interpret.

Narrative Instructions: (Continue with eyes closed) Gently let us change to our ears. What can you hear? Is it the wind in the trees?...is it your own breathing?... is it the birds around you? What do you imagine the birds are saying?...is it the branches of the trees breaking? Does this silence mean anything to you? Inhale...exhale...inhale...exhale...

Step 4. Touching

Activity description: Our skin is the main organ in our body, its design works as a receptor of the environment we are living in. The benefits to perceive with different parts of our body helps us to react to climate, to suffer allergies and to socialize with others. Feeling our sense of touch can help us to have a direct relationship with our local place, and can help in the pursuit of shelter and comfort.

Mentioning analogies, metaphors and scientific facts related to the activity will also help in the understanding of our biological roots. For example, in the section of touching, it is recommended to describe an interspecies experience, narrating: "Imagine that you are a flower or a leaf that is tracking the sun, find the sun" or, "Plants also have a sense of direction, and it is proven that they can see with the sense of touch, reacting to the heat". Telling facts about an organism can produce emotions and the best results for achieving biophilia.

Narrative Instructions: (Eyes still closed) Now let us focus on your sense of touch. And really feel this place on your skin. Can you feel the wind in your face? Passing by your neck, passing through your fingers? Is it making you smile? Can you feel the ground on your feet where you are standing? Do your shoes allow you to feel the little slopes of the terrain where you are standing? E.g. Imagine that you are a flower tracking the warmth of the sun. Now you can open your eyes.

Step 5. Attuning/Balance

Material: blindfolds
Time: 15 Minutes (in pairs)

Activity description: As we walk, we use our eyes mostly but we also use our sense of balance. What happens if we start using our other senses? Being blindfolded will stimulate the use of, and connection to, our other senses. Blindfolding will make us notice the environment, transport us to another dimension or interpret how another living being might sense.

Narrative Instructions: By being blindfolded and guided by one of your peers, you will be using your sense of balance and at the same time using the senses we have just explored. We will be guided to explore the surroundings. Try to describe to your peer what you are experiencing. Pay attention to the textures of the tree trunks, leaves, branches, soil. We will try to smell their scent too and pay attention to the steps that we make and the noises we hear. Your partner will help to guide you in order to allow you to encounter the trees, stones and also to avoid obstacles. After 10-15 minutes you will exchange the blindfold with your partner.

Step 6. Tasting

Material: Tea (local herbs preferably), tea pot and cups

Activity description: The sense of taste can give us pleasure as we eat, we use it as a way to identify healthy food and our sensory system sends signals to our gut and brain. We usually do not allow enough time to identify what we are eating. Being mindful in what we are consuming can also make us think. For instance, where does this food come from and how good is it for our body.

Instructions: Prepare water for tea and cups for the entire group. In the same outdoor spaces or teaching facility, clear the space and get the students seated on the floor in a semi-circle. Serve them the tea and let them smell the aroma of the herbs and have some sips, following the instructions.

Narrative Instructions: Let us relax before having your tea... Close your eyes and try to smell the aroma of the tea. How does it smell? Sweet, sour? What plant do you think it comes from? Now let us have a taste, and retain a little bit in your mouth, and then drink it. Is it a stronger or lighter flavour? Is it sweet, sour, bitter?...slowly have another sip and feel it passing through the back of your throat. Do you recognize the flavour? From what plant does it come from? You can finish your tea by thinking of the benefits for your body. Smell, taste... drink slowly.

Step 7. Conversations on Sensing the Place

Activity description: Seated in the same space, we conclude the exercises by starting a conversation about the emotions experienced... Their favourite or strangest moment on sensing the place. Sharing their experience with the group will create a bond between the students, and also with the place where they will be learning.

Narrative instructions: We are now attuned with this place. And we will become mindful about why we are in this place and how we will be learning here. Let us share some of our experiences. Key questions to each student: how do you feel? What was your favourite moment? What was your strangest feeling?

Narrative reflection on Biophilic Values: This practice may be first experienced in our childhood, where unconsciously we feel free to explore the unknown in that garden, forest or beach. By re-acquiring our sense of place, we not only connect to this place but we create a bond with the living world. Our senses, full of curiosity and wonder, encounter a new place or a new living organism and we become aware of our natural history through using these senses. We are able to see the aesthetic, the human bond with nature, the negative sensations, the need to keep exploring nature, even a kind of moral or spiritual sensation!...those are biophilic values that we need to be aware of when we design.

See Research Explorations (3.1.b) for this activity.

c. Mindfulness and Biophilia: Awakening the unconscious self

As we enter into the realms of consciousness and biophilia, we enter into the realms of meditational practices and the self. Being ecologically conscious lies on the individual level and within our psyche. Reconnecting the self with nature requires the ancient practice of being aware of one's sensory experience in the present moment – or 'being mindful' (Siegel, 2007). In order to cultivate a relationship with our world and well-being with all life forms, we need to be conscious of our minds and our bodies.

To heal our society, our psyches must heal as well (Macy and Brown, 1998a). Questions, such as; what is this world that I am a part of? and, What contribution am I making? correspond to acquiring, not only an ethical way of being, but also a mindful way of being. Individually appreciating life and all its interconnections requires us to see the value of being 'here and now', as is defined mindfulness. Mindfulness is the capacity to be aware of what is going on and what is there (Hanh, 2014). Our way to see ourselves in place and 'in the moment' will allows us to be human. We all are capable of cultivating our 'wakeful presence'(Roszak et al., 1995, p. 207). Creating designs by being aware of what the Earth is telling us to do, and what we need from the Earth, is to create mindful design.

The separation and degradation of nature affects our ecological psyche. Mindfulness is a matter of ecopsychology. For example, 'Why I feel 'I' no longer exist, when I see the sea' (Clayton-Smith, n.d.), is an instance of reflection that leads to mindfulness. Activating this creative dialogue with the self and nature then facilitates a creative intelligence, accepting how humans can awake to create meaning. Manifesting this awakening of our unconsciousness will then allow us to recognize our biophilic worldview and creative mental development.

Mindfulness, in the words of Henepola Gunaratana (cited in Borden and Collins, 2014, p. 335), is to observe without criticism and surprise. It is a balanced interest in things as they are; it is not thinking, it is perceiving; it is attention. Being mindful of the present moment without dwelling on judgments, enhances a sense of equanimity and clarity, and increases empathy and relational satisfaction (Siegel, 2007). Sensing ourselves in nature can lead to developing curiosity, openness, acceptance and love toward what is going on in this moment, within us and in the place.

Practicing mindfulness is a key feature of meditation. As part of planetary heritage, mindful meditation is a well-known, non-sectarian practice, although it has roots in Buddhist tradition (Halliwell and Heaversedge, 2010). The path of practicing mindfulness meditation will lead to finding a place within the self to encounter the world without preconceptions, and encourages us to do 'all of this every moment in our daily lives' (Weiss, 2004, p. xvi). As anthropocentric practices have come to dominate our consciousness, our culture is losing the understanding of the importance of meditation as ritual. Meditation is a kind of ritual that can help to affirm the interconnectedness or the human and non-human, helping to recover the loss of connection with the 'self'. The anxiety, depression and addiction that we are experiencing, by the loss of our relationship with nature, is reflected in the maladaptive patterns of our society (Siegel, 2007).

The previously discussed biophilic practices of feeling the senses and the place can be considered as meditational as we become aware of ourselves. But it is by continuously practicing mindfulness or meditational exercises, and reflecting on such actions, that help the biophilic student develop toward full engagement with nature. The following exercises are an example of how to conduct a mindful meditation session. This activity is based on the Body Scan led by Andrahennadi in sensing the body as part of her Mindful Design Practice (MDP) framework (previously described in activity 2). Her MDP module helped the researcher to be 'mindful' about the fact that the MDP framework can be regarded as a biophilic practice.

Activity 3. Bio-Meditation

<u>Step 1. Sensing your body</u>

Material: Singing bowl or bell.

Location: Forest, beach, meadow or quiet room.

Duration: 10 minutes

Activity Description: Clearing our minds becomes important in every aspect of our lives. Our thoughts affect our behavior and meditating will help us to be aware of the moment, the place and ourselves. Mindful meditation is an individual experience and usually involves sitting in a special posture. To start, we have to be seated on the floor, or pew, in the selected space. Closing our eyes and ringing the bell/singing bowl is optional. We will use our mind to scan our body and feel every part at a slow pace.

Narrative Description: By closing our eyes, we will find a comfortable position to sit down (...) inhaling (...) and exhaling (...) by aligning our spine and relaxing our shoulders (...) we are going to start scanning our body, feeling it in every part. Let us focus on the crown of the head (...) we will continue to visualize our forehead (...), our eyebrows (...) ... until we reach our toes, at a slow pace.

Step 2. Sensing our body 'in' the place

Duration: 10 minutes

Activity description: Seated in the same spot, we will conduct the learners to feel immersed and be aware of their body, our mind connected to the place. Ringing the bell/singing bowl is optional.

Narrative Description: By using our mind and our sense of hearing, we will be acknowledging the world around us in this moment. By closing our eyes, we start paying attention to our breathing (...) Visualize this place in our minds, the trees (...), the grass (...), the noises (...), the water (...) the silence (...).

Step 3. Remember our encounter with nature

Duration: 5-10 minutes

Activity description: Where are the minds of the students right now, in this place? Nature has the power to heal our stress and clear our minds before starting the creative process of design. Remembering moments of being in nature can help us to focus on the topics we are learning and make us become more sensitive with our minds. In this step, and still with eyes closed, you will guide the learners to try to remember a place that they used to visit, to admire or play during their childhood.

Narrative description: Now let us focus on our thoughts. What is on your mind? How are we feeling in this place? Let us go back in history and try to remember our first encounter with nature… Is there a landscape? How is this place? Are there any animals around? Who are they? Does this make you happy? Curious? Scared? Are there any plants around? Water? How is this place? Are you in this place? How is the light? The sound? Breath…exhale…breathe…

Step 4. Group Reflection

Activity Description: Seated in the same space, the facilitator will conclude the exercises by starting a conversation about their experience 'on feeling their bodies and this place'. By sharing amongst the group, their personal experiences will make them self-realize the power of being mindful.

Narrative on Self-realization: The point of this practice is to help to find yourself in this world and moment. It also cleans your mind and makes you more sensitive about what is happening in this place. By remembering your first encounter with nature, you will be able to look back in your personal history and pay attention to details. Being mindful about nature is fundamental for you as an individual and as a designer. You are able to become more sensitive in your creative capacities.

See the Research Explorations (3.1.c) for this activity.

d. Ecosomatics and design: Stimulating our creative body

Being aware of our body through movement is vital. The sensations we experience in our bodies when we move consciously represent the need to feel it freely, and in tune with our world and with each other. Designers familiar with ergonomics should not ignore how the natural forces mould our body. After all, our bodies have been adapting through millions of years to different climates and locations. Crafts, technology and housing are adapted to our bodies. Now more than ever we must be aware of how to embed them within our planetary functions:

> *Our body is our first environment; it is the medium through which we know the Earth... neither body nor landscape are separate from our fundamental selves, but in a culture which views the body as a mechanism to be trained and the landscape as a resource to be exploited, we need to learn to see again their fundamental wholeness and interconnection...The intricate relationship with the earth we inhabit should be obvious to perceive in our body...our bodies know so much and it is our job to learn to listen'* (Olsen and McKibben, 2002).

The premise that Olsen highlights represents the idea that we can feel good with our bodies by enjoying our physical capacities. As the creative individual understands that the body is a dynamic entity, like the Earth, this *somatic* self-realization is an achievement for the biophilic being.

Somatics refers to the art and practice of sensing the *soma* – the ability to feel one's own body as a system. Thomas Hanna (1988) coined the term to distinguish the inner body from the outer, gross body. *Soma,* from the Greek *somatikos* (living, aware, bodily person), is referred to as the innate knowledge of our own body, and this encourages us to participate deeply in our own healing. Body movements can be re-patterned to release tensions and enjoyment (Lindegger, 2011, p. 228). Recent studies also describe how people with the ability to tune into signals from their own body are more emotionally sensitive and empathetic (Wilson, 2013).

The relationship between somatics and ecology, or *Ecosomatics,* is uncovering new dimensions by expressing what it means to be human in the most global and essential way (Enghauser, 2007). As an emerging interdisciplinary field, ecosomatics connects movement, education, improvization, healing arts, ecopsychology, performing arts and play with ecological consciousness (Lindegger, 2011). Such practices heal the separation between mind, body and the Earth by encouraging direct sensory perception of one's body, both *in* the natural environment and *as* the natural environment.

Embodied arts and activities, such as community rituals, planting trees or harvesting food, singing or dancing, can be applied as sensory experiences. These activities can even help to highlight analogies between patterns in nature and those which we sense in our bodies, thereby helping us to create 'effective ecological designs' (ibid, p. 228). The integration of biophilia theory through meditation and, finally, through the creative expression of our bodies (tai-chi, yoga, qigong, etc.), might help to guide us to a holistic understanding of the biophilic being. Incorporating ecosomatics into biophilic practices not only stimulates our psyche to become consciousof the world with our bodies, it also triggers creative ways of designing ways of being with-in our planet.

In the history of design pedagogy, there is a record in how Johannes Itten, one of the teachers at the Bauhaus, used meditation and gymnastic exercises as pedagogical tools to develop harmonization between mind and body in order to pursue artistic endeavour (Ince et al., 2012). Even walks, trips, sleeping outdoors and related practices were used by other Bauhaus teachers to develop creativity (Droste and Gossel, 2006). Itten placed an emphasis on spiritual openness and peace of mind as a means to free personal expression. Its affiliation with Eastern philosophies, and the rejection of mass production during that time, resulted in the ridicule of it's exercises, causing its retreat from this school. In the present days, with good explanation and openness, such philosophies can still be considered irrelevant by some art and design education institutions. However, this research is intent on embracing them.

Itten also believed in enforcing self-reliance – or finding the sources of his own self – in the students. For him, training the body as an instrument of the mind was of great importance to instruct a creative person. Itten's teachings, during his years at the Bauhaus, and after working in his own school, involved relaxation, breathing and body harmonizing exercises[25] to establish the intellectual and physical readiness, which made intensive work possible (Itten, 1975). Beyond this, he trained his students to acknowledge their breathing in their daily routine. With the supplement of relaxation, sound and breathing whilst attending lectures, he created the necessary receptiveness in his drawing classes. He also commented on how newly arrived students joined the morning exercises with puzzlement and inner resistance, but after only a few days most of them were ready to take part with enthusiasm (ibid, p. 12). Itten's design pedagogy is an example for the need to search for additional ways to develop biophilic somatic practices.

The Vietnamese Buddhist teacher, Thich Nhat Hanh, has promoted *Mindful Movements* (Vriezen and Hanh, 2008). He developed such practices based on Eastern traditions of yoga, tai-chi and qigong. Suggesting that, by simple and deep motion, the mind will start focusing on the body, enjoying every gesture. He describes how this series of movements are another wonderful way of connecting your mind and body in mindfulness. For example, Qigong, the ancient Chinese practice, can help not only to work with our 'life energy' to improve our health and harmony with mind and body, but also to develop an intuitive sense of the beauty of the living that surrounds us. It helps us to develop our integrity, creating confidence, self-control and ethical behaviors (Cohen, 2000, p. 7). Therefore, meditational and other mindfulness practices that include movement and performance (theatre), can have a great effect on the way we dwell in and craft our world. Suitable guidance related to practices of reconnecting with our bodies and ourselves are vital for being prepared to bring new designs into the world.

Harmonization creative exercises such as those of Itten, embodied arts and Nanh Han's mindful movement, are the sources of inspiration for developing the following biophilic somatic activities. The participation of the researcher delivering a session on mindful movement and tai-chi, as part of the Mindful Design Practice module workshop with Andrahennadi (2014), affirmed the incorporation and refinement of this activity. This session was conducted with Miss Andrahennadi, at an MDP retreat at the Dundee Botanic Gardens and Tentsmuir Beach in Scotland (see page X). The importance of

[25] See glossary: Itten's body exercises

performing instinctive ways of knowing, perceiving and creating with our bodies, as we learn to be designers, will also stimulate the importance of inhabiting and feeling nature. It is hoped that such experiences at the beginning of any course will not only nourish and stimulate biophilic minds, but enhance the individual creative capacities of doers and makers.

Activity 4. Movement

Step 1. Mindful Movement: Nature's Movement

Location: Preferably near trees, beach, meadow
Duration: 10-15 minutes

Activity Description: Moving your body and immersing it in a peaceful flat space surrounded by trees or near the beach is optimal. The facilitator will guide the learners to follow the *Ten mindful movements* (see Appendix B.6). It is recommended that you have the group behind you, to let them hear and see your movements. You will repeat the same movements (4 to 5 times) before moving onto the next one.

Narrative instructions: The following mindful movements will help you to liberate fixed thoughts and connect your mind, body and the Earth. Focus on my body movements, my instructions and then let us enjoy the repetition by feeling your body, the air and the place we are in. Enjoy and smile. We are going to start by following these basic movements and concentrate on your breathing. (Start the 10 mindful movements)

Step 2. Mindful mimicking: Game bio-extend
Location: Outdoor place or indoor teaching space
Duration: 10-20 minutes

Activity description: After a break from the previous activity, you will encourage integrated teams (or maybe teams previously organized for a project) to choose their favourite organism and mimic its movements or postures as an improvized playful performance.

Note: As an improvization playful activity, you can use it as an energy booster after a break. You must take notes of what their favourite organism is and then use it in the Biomimicry section (to be discussed in the following chapter).

Narrative Activities: You already know how easy it is to feel your body. But what about our non-human fellows? You will choose an organism that inspires you and mimic its movements (like Charades). You will show it to the group and they have to guess what it is. You have 5 minutes to design a mindful moment, a dance step or just mimic how the organism moves by doing a pose. As an ecosomatic playful exercise, you are open to laugh and applaud the performances.

<u>Step 3. Mindful Walking</u>

Location: Outdoors
Duration: Varies
Material: Diary

Activity Description: After the outdoor activities, we recommend that the students be aware or be curious about the place they are situated, while they walk back to the classroom, enter the facilities, or during the breaks. Walking meditation is a technique that can be used to help in relaxation. Being aware of the daily activity of walking will become an adventure during the course.

Narrative Description: During the module/course, you will be able to take notes, keywords, drawings or pictures and keep them until the end of the course as a record of your learning journey. Pay particular attention to anything that you find interesting whilst you are walking back or during the breaks you take to be with yourself in nature. (Please note that outdoor walking with others during your leisure time could also be included).

See the Research Explorations (3.1.d) on this activity.

3.2 Finding meaning in Nature: *Understanding Stage (Convergent)*

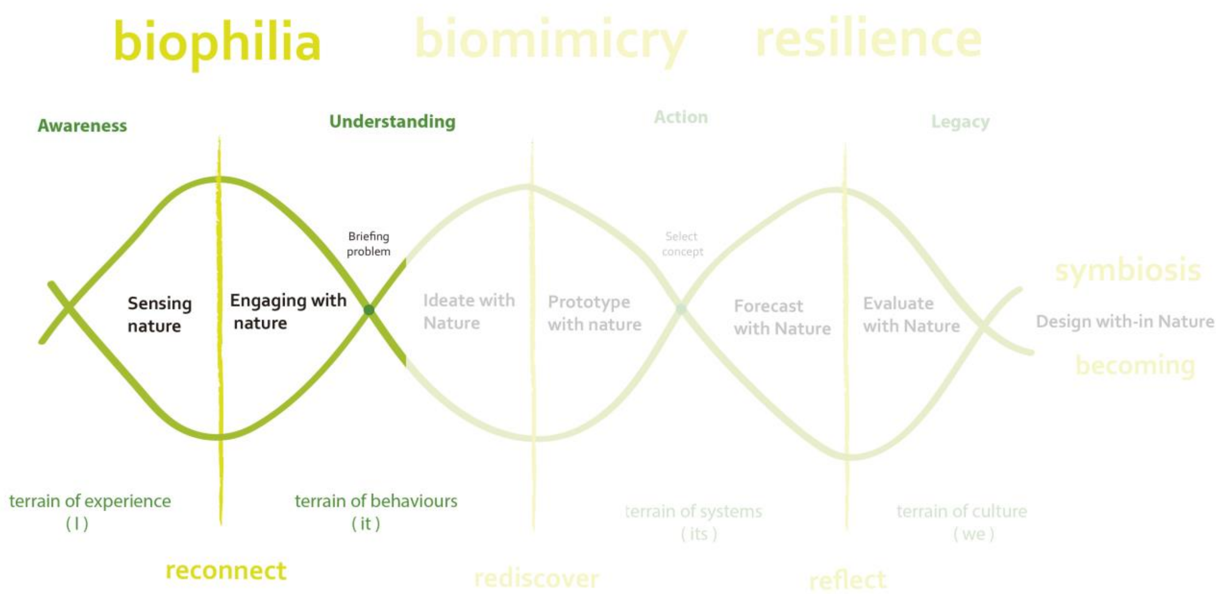

Figure 18. Biophilia Understanding Stage

At the *Understanding* stage, the biophilic being is formed as the student begins to go beyond their senses, paying particular attention to the details, calls, patterns and the design in nature itself. The student starts to converge in nature, *engaging* deeply and approaching what nature can reveal before star debriefing any design challenge.

i. Rewilding our minds

Our biophilic learning rules have been damaged through our human history. Although they have persisted from generation to generation, these learning rules are atrophied with our artificialities and technological dependence today (Wilson, 1990, p. 32). It is on this premise that 21st century educators and their institutions should start to, not only rewild future generations' minds, but to embed biophilic values in the development of designs. This kind of ethic is the duty of letting nature inform the development of our technology. In other words, search the capacities to be open to learn how nature adapts to us and how we can adapt to nature as a means of co-designing for a living planet.

It is clear that nature is humble when we lose the fear of manipulation or conscious co-operation. For example, if we zoom in at a micro level to understand soil interactions with the atmosphere, or zoom out and observe fragile ecosystemic decay, we respond with ethical actions of non-exploitation; this is a kind of biophilic interaction. This allows us to find ways of interspecies feedback (language) and meaningful regenerative design, for example. The notion of biophilic design (Kellert et al., 2011) is gaining importance in the design academy, but also in the development of initiatives beyond conservation, such as 'rewilding' (Monbiot, 2013, p. 10). Plans to create biophilic cities (Beatley, 2010) have been shown in USA, Norway and the UK as ways to enhance the quality of life of citizens and also urban wildlife. We feel mentally and physically good when we are close to trees or birds; such biophilic integration fills our spirit.

For Monbiot (ibid), rewilding is about resisting the urge to control nature and allowing it to find its own way. It is also an effort to rewild human life, a life richer in adventure and surprise. It is an opportunity to enjoy technology but also choose the delight of engaging with nature. For Olson (2012, pp. 9–18), to *rewild* means 'understanding and unlearning our conditioning, the cultural programing that determines how we see and interact with the world'. For Higgins (Higgins, 2013), claiming our wildness is a gift that gives us aesthetic pleasure, relaxation, restoration, tranquillity and an authentic childhood. This return to a wild state, or the process of unlearning, encourages our civilization to become uncivilized, which means to really reconnect with nature.

Rewilding our mind, or in the broad sense, our social interactions with nature, is to accept our biophilia. Every single organism is here to encounter us and perhaps to give us a gift. It is time to turn back and have a kind of interspecies interaction. This could be through an object, a dance, a building; we are here to inhabit this world together.

ii. Biophilic beings, biophilic designers, biophilic world

In the last decade or so, many academics and individual publications have promoted the benefits of an organic lifestyle. Growing food from healthy resources, doing exercise (including meditational practices), promoting welfare for animals, regenerating abandoned urban spaces and building social bonds, are some examples or that kind of lifestyle. As we become more knowledgeable of ecological issues and seeing the failures of our economic and social organization, we start noticing the unbalance we have created. The comfort, strength, calm, happiness and wonder that nature provides, develops our need to pursue that kind of biophilic response. Organic interactivities not only make us aware of nature, they make us understand that human life is an important 'organ' for a living planet.

As biophilic design is gives to the notion of nature a more prominent role in our lives by incorporating environmental values into our behavior, it also reveals the connections between ecosystemic health and socioeconomic benefits (Kellert, 2005, p. 33). Representations of wildness, wilderness or wild behaviors emphasize the need to allow other non-human beings and human society to cooperate authentically toward a meaningful convergence. This relationship contributes to educate, enable and invoke the virtues needed to change our narrow worldview (Cooper, 2012, p. 50).

For instance, the design of our living spaces, by integrating biophilic features such as parks, vertical gardens, roof gardens and other organic features that welcome urban wildlife in our cities, reveal an evolving step in the human mindset. Appealing urban green spaces within hospitals, or creating urban green spaces to grow food and exercise is to create nutritious and healing spaces (Beatley, 2014). Strategies to regenerate lost rivers that cross entire cities, remove motorways to make space for walkways, and the reuse of infrastructure for wildlife shelters, are a few examples of the efforts to eliminate substitutes and archetypal images of nature. The organic design proposed in the past (Kellert, 2005, p. 128) is finally coming alive by realizing our biophobia of over-consuming and removing the rights of nature.

Having direct experiences with nature is having a healing effect. The kind of design that emphasizes the curative strategies is creating a new lifestyle. Citizens around the globe are making an effort to prevent and find lifelong good health. In his thesis *Design for Human and Planetary Health*, Wahl (2006) discusses the work of Aaron Antonovsky, who coined the term *salutogenesis*, refering to it as an approach which seeks the promotion of good health rather than the curing or even the prevention of the disease. Related to the work on biophilic cities, Beatley (2010) also refers to how Antonovsky's salutogenic approach of understanding human health is profoundly more complex, and seeks to understand what will lead to a long, healthy and meaningful life. For Beatley, a combination of factors leads to what he calls *Sense of Coherence*, defined as 'a generalized orientation toward the world which perceives it, on a continuum, as comprehensible, manageable, and meaningful.' Finding this sense of coherence in our designed environment is not only to pursue biophilic cities but biophilic minds and bodies. Therefore, to develop that kind of biophilic mindset, we need to train the desire of encountering nature and liberate the idea of being separated from nature.

Going beyond the triviality of nature, in images, light, color, plants and ventilation connects us with the 'outside' environment. We need to approach nature by finding the value of real green spaces, water spaces and wild spaces that make us observe the basic and complex relationships with nature. It is to develop a sense of coherence. These actions could lead to the healing of our biophilic minds, bringing creative minds together to promote the meaningful biophilic designs, by understanding the human need to grow such creativity along with the natural world.

3.2.1 Engaging with nature: A conscious affiliation

Engaging with nature goes beyond ethics and aesthetics, as it touches our emotions. Keagan points out that emotions, rather than reason, are the wellspring of human motivation, as these guarantee commitment and the pursuit of virtue (Ridley, 1997, pp. 141–44). Such virtue can be interpreted as an instinct; being instinctive is part of our human nature. Understanding how Ecological design and its ethics are sometimes drawn upon, taken for granted and cherished, are a fact of emotions as we engage with nature.

Encouraging biophilia, then, is as important as encouraging creativity. The design academy should therefore place greater emphasis on this virtue. This self-interest is not instinctive. If our moral principles require an innate capacity for guilt and empathy, it is in the same way that such moral principles must be learned. Showing students how to appreciate nature is to show them ways to find inspiration and empathy; the self-interest dependent upon the stimulation of the individual.

Nevertheless, such reciprocity will always be a moral virtue. To illustrate this capacity, one must find answers in nature. The capacity to be curious and to engage with nature will encourage us to rediscover nature and deeply question our values. How can we guide students to acquire this engagement, a worldview that is definitely not compulsory but is rather a learning experience? The following section incorporates the notion of rediscovering or enhancing the naturalistic lens by the designer in order to seed the self-interest without any subjugation. Using our sense of curiosity and wonder forms a common sense to love life and engage with nature.

Being receptive to what nature is telling us implies practices that not only enhance our moral reciprocity with the natural world but with our inner selves (Cooper, 2012), preparing us to use our ability to wonder and ponder about the possibility of new discoveries. But why is it important to study, engage or even identify ourselves with the way of being a non-human organism? Biologist Karl von Fisch points out that single species challenge us with the mysteries of life (cited in Kellert and Wilson, 1995, p.10). By studying the way of life of non-human organisms, designers can find hundreds of secrets that can inspire us to design and also help us to reflect on human creative gifts and values. Can we imagine what would happen if we encourage students to choose a creature that appeals to them in order to discover a secret in the life of such a specimen? Is it possible to have a conversation/interaction with a frog, with a tree or with a landscape?

E.O. Wilson suggests that a true naturalist is a 'civilized hunter' (Wilson, 2006). Inspired by this imperative, the designer as biophilic being should be someone who is capable of seeing with other eyes and following their senses, instincts and emotions. As designers, learning how to become biophilic means being sensitive toward non-human beings.

The following activities were tested, taught and reviewed as a way to activate students' creative biophilia by finding, in nature, the details, and in them, the emotions, that move the individual toward ecological behaviors and ethical responses, before commencing the design process through biomimicry (to be explored in chapter 4).

3.2.1.1 Engaging biophilic practices

a. The Goethean Method as a way to achieve biophilia

Rationalized by Johann Wolfgang von Goethe, one of the few polymaths who developed a deep curiosity about natural phenomena, the Goethean Method uses rigorous attention to direct experience, empathy, intuition and imagination as a pathway toward meaningful insights into nature's creative process (Wahl, 2005).
Goethe believed in a different sort of science, a science that united art with direct experience of phenomena and natural studies. In his approach to science, he believed in the need to see with your 'whole self' – capturing a feeling, a sense of experience or an emotional reaction. In other words, understanding 'what it is like to be the phenomenon' (Brook, 1998) being studied.

Goethe described his method as delicate empiricism (*zarte Empirie*) – the effort to understand a thing's meaning through prolonged empathetic looking and seeing, grounded in direct experience (Seamon and Zajonc, 1998). His artistic science or method of observation encourages one to 'encounter', to use our senses to empower our perception over a prolonged and regular practice. Goethe's artistic approach to science allows for a more 'appreciative, qualitative, meaningful and participatory engagement with nature' (Wahl, 2005). In sum, his approach can establish ways to respond meaningfully in design.

The Goethean Method offers ways of understanding the language of nature as we become 'in conversation with' a plant or an animal; therefore, the method is a way to achieve biophilia. The sense of seeing (or observing) is the one we use most as designers. Observing nature, to some extent, is learning to encounter, becoming the organism and developing a creative response.

As a trigger for creativity, the Goethean method promotes a meditative technique for encountering the whole. As we become one with the organism, we conceptualize to serve the organism, 'we lend it this human capacity' (Brook, 1998, pp. 5–6). As we establish deep empathy, we will be able to expect wonderment and inspiration. This response is when the symbiotic consciousness is also likely to emerge.

The way that an artist stands still to draw a flower is not much different to the way a scientist sits to explore an organism under the microscope in order to find answers. The Goethean Method involves observation and the drawing of plants based on various steps,[26] which can help to nurture 'creative consciousness with nature' (Colquhoun, 1996) (Irwin, 2004) (Wilson, 2005).

The Goethean method is a fundamental skill that should be adopted by design disciplines. Indeed, as biophilic practice, it can help to enhance the aesthetic achievement of designers whilst reinforcing their ecoliteracy. It is also a tool used to bring meaning into the world and design accordingly with the non-human being. The following activity incorporates the Goethean Method, implemented as a way to enhance the naturalistic lens.

Activity 5. Seeing

Step 1. Perceiving our world (intuitive perception)

Location: Greenhouse, meadow, beach or garden
Material: Sketchbook. Watercolors or color pencils are optional
Duration: 25-35 minutes minimum.

Activity Description. The first step is learning about the origin of the Goethean Method. This involves acknowledging our own personal involvement in how we meet the world and the fact that we all habitually employ a set of basic

[26] See glossary: The Goethean Method Steps

assumptions and concepts. We all have history as observers and have formed ideas about the natural world, which influence how we perceive it.

Activity instructions: You will ask the group some difficult questions. What is perception? How do you perceive the world? Allow one or two individuals an opportunity to share their thoughts. You may be able to share your opinion as teacher or facilitator. Pause for a moment and express: "It appears that we do not know how to see the world and this is fundamental for you as designers. Let's learn how to accomplish it." With the group make your way to an outdoor space or greenhouse (as previously selected). Have templates of the Goethean Method Steps (see Appendix B.7) already set aside to bring to the location. Using the template as a guide, and their sketchbook, ask the students to follow the instructions by unfolding each step.

Step 2. Exact sensing (perception)

Activity Description: A detailed sensory-based observation of the phenomenon is undertaken, noticing only what can be outwardly perceived by the senses. Judgment and personal preconceptions are suspended and observation takes place in an open and listening posture. The phenomenon is viewed as if this is the first time they have seen it.

Narrative instructions: With your Goethean Method Steps template, you will select a plant of your preference and find a relaxing posture and observe it in detail as if this is the first time that you have seen it. The plant or the tree you select is not simply a plant, it is a unique phenomenon. Ask yourself, what is this? And observe it again for a further 2 or 3 minutes.

Step 3: Exact sensorial imagination (imagination)

Activity description: This phase involves using your imagination as a legitimate tool for scientific or artistic observation and for entering into another way of knowing. We will focus our awareness by imagining the natural flow of the phenomenon we observe.

Narrative instructions (or let them follow the template): Stop observing the organism and now begin to draw the element as you remember it. Think about the sequence of its leaves, the position of its flowers or bulbs, its roots, colors, etc. When you have finished the drawing, write the name of the organism or invent a new name.

Step 4: Seeing in Beholding (Encountering)

Activity description: In this stage, the aim is to suspend active perception. We simply behold the phenomenon in the dynamic awareness we have reached through the use of our imagination. We allow the organism to express itself through the observer.

Narrative instructions (or let them following the template): Now go back to observing the organism and be ready to encounter it, see who it really is. It is no longer a thing but a living individual organism. So, let it express itself. Revisit your drawings and continue adding more details: extra leaves, colors, dry branches, roots etc.

Step 5: Flow with the time (Imagination)

Activity description: What was observed as static, disconnected parts are now brought together and made fluid in the imagination as a dynamic process in time. The intention is to experience the unity of the generative process. The imagination is used as a tool of perception to visualize the coming into being of the form and its journey into the future to completion/death. The absent whole is encountered through this process.

Narrative Instructions (or let them follow the template): The dynamic transformation envisioned in the previous stage is now deepened to reveal the formative gesture of the organism or its life-principles through time. Using your imagination again, and observing your drawing, you will imagine how its roots are growing underneath; try to think of the relationships with other beings (bees, fungi, moss etc.). Add some of these realtionships to your drawing in a subtle way. Finally, using one of the corners or the back of your template, you will draw its growing cycles.

Step 6. Becoming one with phenomenon (Intuition)

Activity Description: Through intuitive perception, we merge with the organism form to grasp its inherent meaning or creative potency. As we become one with the organism, we will conceptualize to serve the organism: we lend it our human capacities. Here our symbiotic consciousness is activated. Form becomes an intrinsically meaningful process of the organism and communicates where it comes from, where it is going and how it relates to other forms and processes. Goethe saw this step as an understanding of the plant archetype that manifests in a multiplicity of forms (species and individual plants).

Narrative Instructions (or let students follow the template): Now observe your work and ask, what is the intention of the organism in the world? Look around to find some clues and see how nature relates to us. As we rediscover nature, we become conscious and responsible participants in Nature. The emotion that you experience by seeing yourself as part of nature must be expressed in a poem, ornament or short story.

Step 7: Participatory Goethean Method

Activity description: The variation is that instead of working individually, is to invite the whole group to explore a single plant. Wilson conducted the first three stages giving the instructions for observing the plant.[27] Exact Drawing from memory and Transform stage though the seasons on an individual basis, concluding with an important group activity that allowed connections to be built with others' perceptions.

Activity Instructions:

1. Seeing a plant in silence. Students share what they see and feel using their body to measure and experience the phenomenon (15 min)

   Stage 1. Observing the plant (Exact Sense Perception)

   Approach the plant for the first time, putting aside any fixed ideas or knowledge that you already hold. In silence, spend time looking at the plant. Use your senses to consider its size, color, number of leaves. What state is the plant in, what can you smell, taste? Importantly, what do you feel? Drawing the plant as you see it is important because it develops a sense of observation and attention to detail. Closely observe the plant as we are going to draw it from memory next.

2. Drawing from memory. Use your sketchbook to draw from memory. When you finish, go back and check how accurate you were. Use pastel colors to draw and express how you felt emotionally when encountering the plant (15 min).

3. Students continue their individual drawings of transformation and movement through the seasons (15 min).

   Stage 2. Perceiving the whole plant (Exact Sensorial Fantasy)

[27] Dr Sandra Wilson, a former PhD scholar from the Centre for the Study of Natural Design, introduced this method to our class. Wilson adapted the five steps of Goethean Science learned during her research with Margaret Colquhoun (Wilson, 2005, p. 84(2))

This stage is about movement and understanding the process that the plant goes through. In other words, seeing the plant as a phenomenon in time. We see the plant as a living organism, not as something static, but as something that grows and changes in different environmental conditions. Study the plant – what evidence of growth and change do you see? Can you begin to draw the different stages that a leaf may go through for example? Describe the season with keywords.

4. 'Taking a line for a walk'. This step is with your eyes closed (15 min)

   Stage 3. Seeing in beholding (inspiration) and Stage 4. Being one with the object (intuition).

   In the previous stages, you used your imagination. However, in Stages 3 & 4 you will make a space for the 'organism' to express itself by connecting with your inspiration and intuition. This is a process of trying to internalise what it is that you have experienced in the first two stages. Drawing with your eyes closed, you will begin with the roots of the plant, then it's stem, then it's leaves and flowering. Can you describe the feelings you have from this process? What insights have you generated from the plant? What physical sensations are you experiencing? This stage is often accompanied by an 'Aha' moment! Are you starting to 'see' the plant differently from how you perceived it before? Are you starting to understand the gesture of the plant?

5. Group drawing. In this participatory drawing, the students will participate by adding details or more plants around the drawings of the others. Their individual drawings of the plants are put on the table. This is an intervention that helps to build connections.

Stage 5. Seeing beyond. The fifth stage involves considering what you would grow in a particular place, what could be built, or how plants can inspire new design for creating jewellery, textiles, graphics etc. This stage is about considering human interventions that are harmonious with nature. You can continue with this stage in your studio or workshop.

See the Research Explorations (3.2.a) on this activity.

b. Shapeshifting: Defining non-human centred design

Defining non-human centred design is to enter into the realms of a bioculture or a multispecies approach (Kirksey and Helmreich, 2010). Other species inspire us and manifest in our human language, for example, when we talk about how a forest thinks (Kohn, 2013), our love for insects (Haraway, 2007), fungi remediation (Stamets, 2004) or the value of bacteria in food issues. This sort of multispecies thinking begins to create a bio-civilized approach, ultimately embracing a Gaian or biophilic strategy in design.

Over the years, human centred design approach has been embraced by the design academy (Ryn, 2013). However, to some extent, the link with the non-human centred design has been neglected. Nevertheless, some examples of multispecies grazing (Ruiter et al., 2005), co-construction of niches and regeneration of spaces with other animals (Doddington, 2013), have recently emerged. This culture of biophilia is demonstrating ways toward a bio-civilization, realizing that 'our human nature has an interspecies relationship' (Kirksey and Helmreich, 2010, p. 551).

By establishing an emotional relationship with non-human beings, we can teach future generations to comprehend beyond biophilic values (Kellert and Wilson, 1995, p. 31). It is on this emotional strand that our culture is interweaved with nature, and, to understand these emotion-driven rules, we must relearn our interspecies relationship. We might not know what happened in the past that made us lose interest in creating a shared space with nature, nevertheless, it is not too late to heal such a relationship, and design may help to heal it.

Philosopher Thomas Nagel (cited in Goodwin, 1997, p. 219) questions 'what is it like to be a bat? To open a wide perspective beyond the non-human: 'An organism has conscious mental states if only there something that it is like to *be* that organism – something it is like *for* the organism to know what is like for a *bat to be a bat.'* In this regard, Godwin reflects on the way that philosophers use the term 'be' as both the first person and third person perspectives. He raises the question: is it better to recognise the intrinsic values and qualities in other beings in order to heal our relationship with nature? To answer it, he expresses how another species has its unique relationship to the world; its own experience of what it is like to 'be' itself as an intentional agent engaged in expressing its nature in the context of a particular environment. Such ways of consciousness can be enhanced through biophilic exercises to unlock creativity and to gain an understanding of the eco-self. Acknowledging the life of other beings implies subjectivity, but also enhances the awareness condition of our consciousness in bonding and respecting (Goodwin, 1997, p. 220). This reflection implies the need to expand our biophilic understanding, and in essence, our symbiotic consciousness.

As soon as we begin to appreciate the splendour of other species and know more about them, we will start to fall in love with them, to inhabit with them, to design for and with them (Salazar Preece and University of Dundee, 2011). Forming this kind of biophilic relationship represents a 'sympathetic imagination' (Coetzee et al., 1999, p. 4). This kind of sympathy is formed not only with animals, but with all the living and can give us rational faculties to use biophilia in the right way, from the beginning of the design process. A non-human centred approach, then, is to find our fulfilment as individuals and as a society (Kellert, 2012). Denying this affiliation might only increase the possibilities for designers to continue to create products without meaning, and in doing so affect the human spirit and the health of the world itself.

Abram (2011, p. 58) argues that we are forced to notice this reciprocity: 'whenever we touch any entity, we are also ourselves being touched by that entity.' This interspecies reciprocity is the very structure of our sensory perception, an ongoing interweavement almost as a 'shapeshifting' process. For example, Abram identifies how the *totemism* and Darwin's natural selection are interrelated. Totemism is when we identify animals as guides or as our ancestors felt and perceived by our bodies; it is the same way Darwinism explains how the biosphere has the similar matrix that co-evolved in our bodies (ibid). Breaking such barriers between what is a felt relationship with other creatures and the surrounding terrain is what sustains us, teaches us and inspires us to extract its forms into our technologies. This implies the need to guide individuals to become true humans through such dialogical reciprocity with our animal or plant ancestors, to respond to them through every creation.

Therefore, the practice of non-human centred design can help to re-establish the multispecies relationships we urgently need. Ultimately, we are becoming more and more conscious of another layer of phenomenological understanding. Certain indigenous communities around the world (Ridley, 1997) know how to interpret this language by setting up limits to consume, worship and establish ecological ethics in their land. Natural sciences are also going beyond ancient knowledge by finding ways to connect our system reality to a more holistic worldview, as is Gaia Theory. It is apparent, then, that the challenge of the contemporary ecological designer is to interpret and respond to nature's patterns and languages to inform design that integrates them in our societal pattern. This kind of biophilic response, adopted by design disciplines, might help to drive our humanism with the planet, reshaping it into a bio-culture.

On this premise, the proposal of 'pulsing and lensing' (Bruce and Baxter, 2008), developed at the Centre for the Study of Natural Design, illustrates a way to develop an interspecies understanding. Lensing helps us to frame non-human centred design; for example, *thinking like a mountain, being in the shoes of a river,* or to use the lens of the scientist in the arts, and vice versa. Lensing is about looking at a design from a different perspective, through 'different eyes'. On the other hand, practicing Pulsing (as will be discussed further in chapter 5), draws the designer into a wider view of the world from where the different lenses are acquired, helping the learner to develop a holistic understanding of problems by going from the micro to macro, or stepping back and forth from the part to the whole, the past and the future.

The previous use of the Goethean method is valuable for developing this lensing skill. This kind of approach enables people to inquire, imaginatively and creatively, into how to turn the narrowed worldview around and see themselves from *outside-in* as inhabitants of Nature. To explore this notion of developing non-human centred design, the techniques of lensing have been adapted as a kind of shapeshifting response to form biophilic beings.

Activity 6. Lensing

Step 1: Becoming Animal/Plant

Location: outdoor place or indoor space.

Duration: 10-15 minutes

Material: Paper, Pen and a bucket

Activity description: Talking, communicating with movement and singing are expressions present in the natural world used to express needs or emotions. In our human language we have ways to understand their behavior with their context and observe how they interact or communicate with us. Can we communicate basic needs or emotions with simple noises as nature does? This playful activity will encourage the learners to use their innate talent to mimic an organism expressing a need or an emotion. (As an improvized playful activity you can employ it as an energy boost after a break or just after showing a long documentary). This activity will seed the notion of interspecies design and intelligence.

The facilitator must prepare tags with animal names and emotions or need (e.g. Horse + joy, or parrot + hungry). Mix them and pick from a container or give them to one participant without showing it to the group. It can be suggested to the group to produce the noise and movements to express the emotion/ need. Alternatively, it can be suggested to use previous animals from Activity 5. Be prepared to hear sounds from the entire ecosystem in the classroom, including the laughing!

Narrative Instructions: Are you aware of what your pet is telling you? Have you ever noticed what an animal is trying to say or how they express emotions? You will choose one of these tags and try to reproduce the emotion – through sound and movement – that is written on the label. Alternatively, if you struggle, you can simply emulate the noise of your favourite animal, expressing an emotion of your choice. The group will try to guess what it is.

Step 2. Smart animals/plant videos (visual biophilia)

Activity description: This activity will help us to affirm biophilic being, which will be linked to a sense of wonder and a sense of reverence for non-human intelligence and design. Pick your own video clips or select from the list (see Appendix B.1) and present it to the students.

See the Research Explorations (3.2.b) on this activity.

c. Enhancing our Naturalistic lenses

As soon as we start paying deep attention to nature, we become interested in everything around us and instinctively begin to appreciate aesthetics and assess ecological issues. We have an innate tendency to learn (Sheldrake, 2009, p. 174). The curiosity that is inspired by the surrounding biodiversity and its impact on our own species is perhaps what keeps us evolving. Design operates in the same dimension. Our curiosity means we look to innovate, generate ideas, explore materials and look for sources of inspiration.

Feeding this innate tendency to explore nature encourage us to explore micro and macro levels and guiding us to the development of our curiosity and wonder. Curiosity, along with necessity, is guided by the struggle and amazement that the natural world displays. For Ball (2012, p. 2), curiosity appears as a radical force that awakens to wonder, and to feel a hunger for strange and new experiences that will break down old ideas and distinctions; it is taming the world – it is a compulsion to *understand*. Curiosity is also a very powerful concept for science and design. The term 'curious' derives from the Latin *cura*, meaning care. It is also linked to the word curator (ibid, p. 8). Curiosity is linked with the concept of wonder and the senses, but wonder cannot be manufactured; it provides modest answers to modest questions, a fact that gives us our humanity (ibid, pp. 406–10). Therefore, it is perhaps wonder, combined with curiosity, that propels us to become interested in exploring both the micro and macro worlds, in making interconnections, in becoming inspired and learning more from our animate Earth.

Biologist Rachel Carson remarked that we must strengthen the 'sense of awe and wonder' (Carson, 1998). This sense is precisely the key to generating ways of engaging deeply with nature that will lead to the realization of her design. Observing a plant, a scene in the landscape, or the change of the seasons, can help us to experience ephemerality, moderation, appreciation of aesthetics and various emotional responses fundamental to becoming a biophilic being that help the designer's mind. This process of mindful engagement is to provide the design student with a naturalistic lens, as the naturalist does when studying an organism. Acquiring this lens may help to trigger more creative responses; in other words, we need a new kind of 'ecological attunement', or scope, to bring human beings and the world into an *empathic mutual relationship* (Rayner, 2012).

Curiosity, then, goes hand-in-hand with the biophilia concept, and also sets the foundations for the biomimicry concept (to be discussed in chapter 4). Being open to understanding why we want to find out more about nature is part of our biophilia. Non-humans perhaps have the same spark of curiosity about us. As we become more curious about our affiliation with nature, we become more open to establishing a relationship with the wonderful features, behavior and lifestyle that an organism may have. We began to start translating, mimicking or interpreting such features. Beyond biology, it also takes us to spiritual dimensions by integrating them into our life. One distinctive fact for the biophilic being is development of their *bio-logic* (Krupp and Wann, 1994), which not only informs how nature works but et's nature teach. Without this biophilic openness, we are unlikely to encounter and to find out more about our *bond with-in nature.* Through a process of teaching-learning, it is possible to nurture that affiliation (Kahn, 2010) and bio-logic.

Developing a sense of curiosity, awe and wonder can enable students to enquire, creatively and imaginatively, as a naturalist. The following activities were implemented as an example of reaffirming such a naturalistic lens and as the last step before commencing the biomimicry process.

Activity 7. Wondering

Step 1: Audio-visual Biophilia 2

Activity description: Prepare some videos in advance to reaffirm the sense of curiosity and wonder. Choose clips related to the project the student will work on. (See Appendix B.1 for the studied and suggested audio-visual material)

Step 2: Collecting Natural Samples

Activity description: In order to ignite the sense of curiosity and wonder in the student, the naturalist activity of collecting samples from plants (leaves, seeds, flowers, bark) or animals (feathers, skin, bone) is an exercise to begin looking at, and rediscovering, the natural patterns and designs in nature.

Given Instructions: Using your curiosity, schedule a visit to a particular place (park, beach, forest) nearby. Equipped with your notebook, a bag, magnifier and camera, you will collect a few samples to bring to the next class. You may have time to draw some sketches, notes or stories of your observations about the chosen ecosystem . You also are invited to find videos or curious data of the organism/ecosystem.

See the Research Explorations (3.2.c) on this activity.

3.3 Reconnecting with nature: ***Reconnect Phase***

3.3.1 Biophilic shift: Becoming animals, becoming humans, becoming designers

Concerned with the ethical and biophilic shift that is needed in academia, Broomfield (Broomfield, 2011) questions the necessity to change education schemes:

> *'To disregard the problems facing the Earth and to proceed with business as usual in education would be a betrayal of trust. Our students want to know how to make a difference. They need hope, and it won't come if all we can offer is another scientific theory or technological fix. We must expand our vision to seek non-scientific alternatives. To make a difference, we must search for different understandings. Let-us look to the wisdom of our ancestors'*

This kind of alternative vision might be achieved through reconnection with nature, because it includes a deeper ethical component, which is biophilia. Experiences of the wholeness, rewilding and related practices, that interconnect us with life, are key (Broomfield, 2011). These are aspects that are starting to be explored by the universities of tomorrow, as the inclusion of reverence, mystery and awe within the sciences and arts bring greater meaning to our humanity.

From ancient cave paintings to rudimentary tools, the communion with the natural world was not just about copying its patterns, but through having a deep understanding. Encounters with life-threatening natural phenomena, such as volcanic eruptions or ice ages and other disturbances, pushed the human race to develop sophisticated clothing, tools and housing to counteract or protect against these potential disasters. It was believed that these events were the invention of the Gods, but the fear was now transformed in reverence to our natural history. Some indigenous groups still preserve this ancient reverence that we have forgotten. Aside from criticism, we need to include indigenous practices (such as storytelling, crafts, rituals) that help us to reveal the intelligence of all creatures, to develop a consciousness to thrive together with our living planet.

As we have discussed anthropogenic factors, such as diseases, urbanization, loss of biodiversity and global warming, are the manifestation of losing connectedness with our fellow species and sacred places. Although efforts to use digital technologies to understand patterns of nature and even to establish interaction with animals are in progress (Reiss et al, 2014), the human race still needs to find ways to reconnect by encountering nature and communicating with non-human species.

Any living being we encounter informs us, inspires our language, alerts our senses, and teaches us about their own design. More-than-human species have been not only a source of inspiration but purveyors of secrets, carriers of intelligence that we ourselves often need (Abram, 1997, p. 15). An interspecies biophilic communication implies asking open questions, borrowing experiences and meditations, so as to find what is out there in a more-than-human world. These aspects are founded in the phenomenological aspect of becoming one with the world, as we live and experience it, becoming human as we interact with the world. This deep wisdom is then able to improve our internal abilities and self-realization; feeling life, feeling the death of the ego, to become biophilic beings.

From the scientific point of view, 90% of our cells are filled with the genomes of bacteria, fungi, minerals and protozoan. Yet despite of being knowledgeable that as humans we are made up of many species, we still maintain the 'great divides' – animal/human, nature/culture, organic/technical and wild/domestic – (Haraway, 2007, p. 15) which demand respect and a biophilic response. This '*infolding* dance of species' (ibid, p. 249) is important to the world-making encounters that keep the animate flame in the formation of a bio-civilized society.

We need to instruct generations that are 'emotionally fired' through the acquisition of a holistic worldview to reach an understanding of values (UNESCO, 2012, p. 14). On this premise, the design educator must be the channel to induct students to acquire those values, in theory, but also to facilitate the spaces and activities to reconnect with nature and then to let them incorporate those values. Without this, we cannot mature in the way that ecological wisdom requires.

What is needed in this time of massive change is to provide to our generation with an understanding of how design can promote biophilia. Moral symbolizations of nature produce consciousness of how one should interact with nature as culture[28] (Eder, 1996, p. 31). As we start to unlock the symbolic constitution of nature through biophilia, we begin to identify ways to perceive design mindfully. To turn our biophilic awareness into a biophilic understanding, we need to recognize biophilia in a value system. Kellert (2012) suggested finding ways of creating an ethical society based on biophilic values. Our capacity to feel, reason, think, master complexity, discover, create, heal and be healthy depends on how we make connections through design with nature. No matter how beautiful the design concept may be, if the designer does not have previous biophilic experiences, the artefact or message might lose meaning and may become a problem.

Accepting that we are living in a healthy, interconnected system means that we need to design with ethical biophilia in order to shape our cities, objects and even messages, to serve our bio-culture. Developing this *philia* will require the adoption of unconventional ways of learning from nature, including rewilding, reciprocal ecology or reconciliation ecology (Rosenzweig, 2003) that can be linked with the concept of biophilic design and the formation of the biophilic being.

3.3.2 Reconnect with Nature before briefing a design need

Design methodologies can be interpreted as guidelines to shape the world; however, in general, they have no ethical basis. Design pedagogy, especially at undergraduate level, is biased only in terms of 'solving a problem/need immediately through a thing', instead of teaching the values, dangers and interconnected causes of the problem behind it.

In some institutional and professional contexts, the design process starts with the development of a brief, or a preliminary proposal, to solve a problem. This initial phase is considered the 'locus and crucible of creativity' (*Encyclopedia of creativity*, 2011, p. 532) which is aimed at translating abstract ideas, technical data, ideas of beauty, forecasts of performance, appeal to users etc. As the notion of designing is defined as a way to solve ill-structured (wicked) problems (*Encyclopedia of creativity.*, 2011, p. 533), the design academy need to train designers to generate successful well-defined questions, to know intuitively and

[28] See Glossary: Assumptions of nature as culture

to place designs in a real world context.

With all the biophilic practices, the point to emphasize is that we need to brief the real context only after experiencing the real world. The awareness and understanding stage works as follows: to encourage encourage designers to stop and contemplate, to ask the right questions of our unconscious biophilic selves about what the planet needs, before starting the debriefing process. Beyond any practicality, there is a call for awakening the eco-self, our pursuit to become as truthful as we can, as truthful as nature. We need to reconnect ourselves and be mindful with nature before any design effort. After experiencing or sensing the self into nature, we connect with the self (I), leading us to become more aware of our role as humans and the non-human dimension. Then, as we engage with the outer self (it), we start to change our behavior toward our animate world. This phase, framed as 'reconnection', prepares or equips students to be ready to start rediscovering nature's design and to be sensitive to the biophilic practices and values learned. This phase then concludes by briefing the design problem[29] (See Figure 18 p.116).

3.3.3 Foundations: The character of the biophilic being

By being aware of Nature's power of sustenance and destruction, we are able to love it and hate it. It is not by accident that we speak both for the laws of nature and for human nature (Cooper, 2012, p. 46). Likewise, words, such as Native (from the Latin *natus*), make us reflect on how important it is for us to feel that we are natives of this planet and how significant it is for individuals, and as society, to embrace this feeling. Discovering the mystery of the meaning of the word 'Nature' for ourselves is the first step on the journey to encountering our role in a sacred design. Nature means *self-born*, and in her lies the affinity of being creative herself, and a realization that it is not a passive blend of chance happenings and mechanically determined events, 'but an unfolding creativity ever coming into being, ever bringing itself forth' (Abram, 2011, p. 303). Such an ancestral sense of affiliation is what we need to acknowledge; it is in our biophilic DNA.

[29] By using the SDP, the brief given or developed by the teacher does not need to be focused on an organism to be mimicked from the start of the module or course, but from a real world problem. This structure can be understood as a seed that will focus on the release of accurate biomimetic designs.

The self-realization comes when we experience nature at its fullest, mindfully. The creative way of ecological design can not only provide the prospect of self-realization, but a holistic notion of the sense of ourselves and of a planetary-self. As we revive the sympathetic bond that we individuals have toward the notion of Gaia, and gently respond to its spontaneous creativity, we realize our biophilia. This recognition is one of the characteristics of the biophilic being.

With the help of stimulative and engaging biphilic practices, we begin to realize our very own sensing bodies and begin to unlock intellectual and aesthetic experiences. Our Earth-centred needs reconciles with our human-centredness. With this realization, the biophilic being learns to reconnect with nature, breaking the boundaries between over-reductive science and new-age alternatives.

Our sense of biophilia is constructed by various senses, including our sense of curiosity, wonder and awe of nature. It also implies a sense of the ethical limits against us and other species. Therefore, the way in which we experience nature can help us to construct a culture of empathy, kinship and affection that is reproduced in human behavior. Biophilic values can be implemented and learned through a design process. We can observe that certain ecological design proposals lack the critical incorporation of those values, focusing only on the material or the aesthetic. In this way, the biophilic being fosters a biological affection to enhance our humane society of being native to this planet. Therefore, the need for design education and design methodologies that permit intuitive and natural ways of perceiving Nature's language is paramount.

One such action is to stop filling our educational systems with anthropocentric approaches that numb our senses and which result in being out of tune with our real context. Becoming conscious of our unconscious presence 'in' nature, before starting to design any solutions, needs to be taken into account by the design curricula. If we continue with this 'education as usual approach', our design actions will lead us toward an unsustainable future.

By acting mindfully and with compassion and appreciation for our nature as biophilic individuals, we can:

- Take greater responsibility for our actions against nature.
- Enhance our ability to mindfully perceive natural phenomena.
- Find meaning in our life and the way we work through our creative actions.
- Support our human and non-human well-being.

In sum, this chapter provided the literature and practices to prepare students to reconnect with nature, allowing them to experience their own sense of belonging to our animate Earth. This first phase, framed as 'reconnection', opens the possibility to guide the student and the teacher to understand biophilia, and to trigger deep ecological thinking. When the individual recognizes consciously his/her biophilic self, then the eco-technique is acquired. This dynamic then creates the foundations to form the biophilic being (See Figure 19 below).

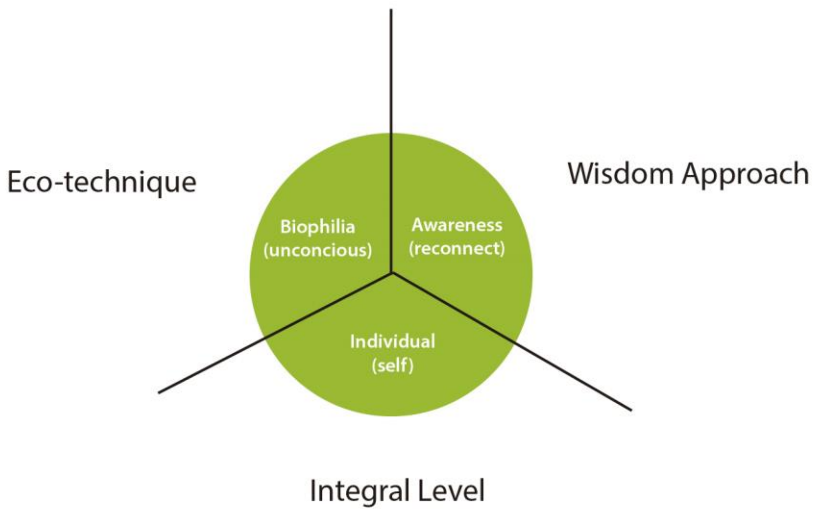

Figure 19. The biophilic being foundations
When we reconnect with our biophilic self, awareness about nature is achieved

The future incorporation of biophilic design through educational institutions and related agencies would require the inclusion of teaching and learning resources, such as the biophilic practices presented here. Mindful meditation, Goethean observations and fieldwork in the outdoors then become integral interrelated practices in achieving biophilia. Valuing the ethics of the individual, and the self-realization that nature provides, is a fact that academia needs to address as broadly and deeply as it can.

This biophilia phase of the SDP is a demonstration of experiential approaches that can enhance individual ecoliteracy and creative capacities. In summary, the awareness and understanding stages provide ways of beginning to question the ecological origin of a design. It is a sensitive way to acquire a new worldview, one that opens the faculties to appreciate nature through our own wisdom. By doing all these basic activities, students are able to develop virtues such as compassion, empathy, openness and other related ethical values that can change their worldview.

These biophilic practices also provide an approach to design, and to question, who we really are as humans. Our biophilic self is caring and creates with love, in service for the Earth. As we self-realize our place on Earth, we are more able to appreciate the land, feel its flavours, changes of seasons and experience the benefit of life and death. The right intentionality of becoming mindful through biophilic practices will prepare the designer for the next stage (Biomimicry), in which the creation of meaningful design promotes the partnership of sensitive ethics and aesthetics of design, inspired by a non-human world.

Chapter 4. The Biomimetic Practitioner: Rediscovering the wisdom of nature to become designers

4.1 Learning from Nature: Understanding Stage (Divergent)

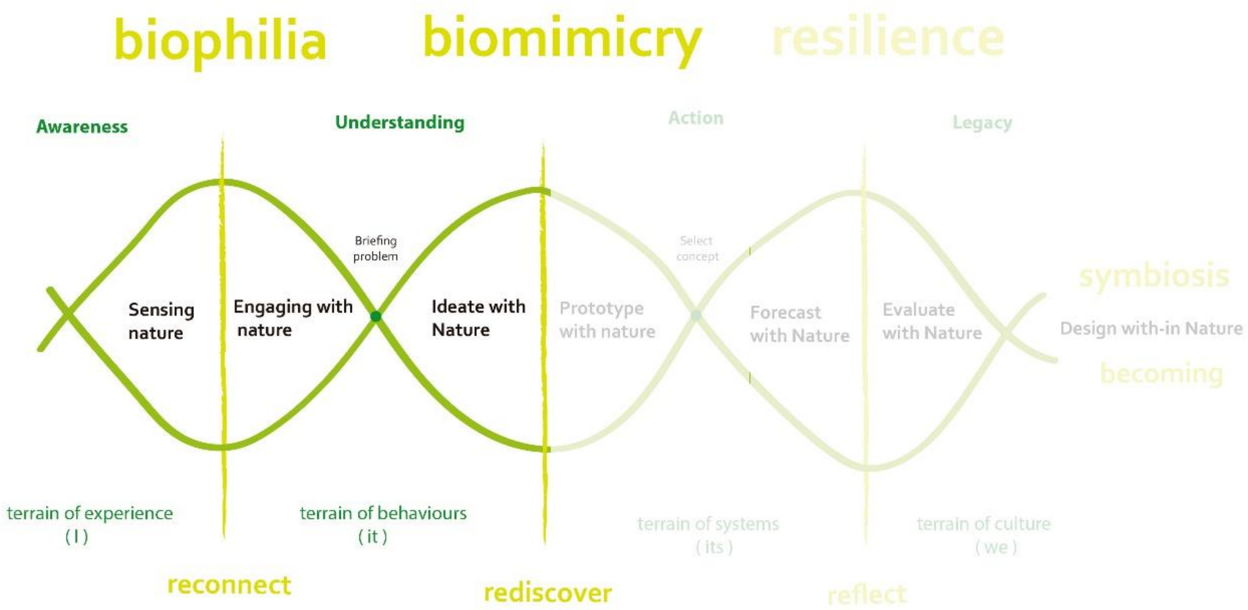

Figure 20. Biomimicry Understanding Stage

The rediscovering phase is when the designer expands their understanding of the patterns of nature and becomes more and more inspired to generate ideas (diverge). Ideation with nature is represented as the third stage of the SDP. After observing natural organisms in detail, we begin to rediscover their creative, ethical and aesthetic order. At this stage, the design challenge is given. Here, the methods and examples on biomimicry are fundamental.

i. The bio-mimetic momentum

A myriad of concepts, performed through sustainable development initiatives and ecological design practices, have begun to emerge in the last decade. Producing fuel from *algae*, designing photovoltaic *trees*, planning of *metabolic* cities, *fractal* social media or investing in *nature's services*, are a few examples. These new initiatives and practices have resulted in the development of a new terminology that reveals the previously invisible layer of design studies that look for reconstitution of our design culture.

Most academic teaching and learning modules related to sustainability or ecological design recognize that being inspired by living systems can add intrinsic value to products, environments and services. Forms, textures, materials, color and functions found in the micro-macro natural world have not only a physical purpose in our human culture, but also a cooperative purpose with the world as a living being. This holistic worldview accepts that animals, plants, fungi and bacteria are not just a symbolic part of an alien landscape, but are designers, engineers and unique beings that are all part of an emerging innovative culture. Through this open connection with design, natural sciences and engineering, hidden patterns are being revealed, thereby allowing human society to embrace an 'age of biology' (Saffo, 1992).

According to Benyus (2002), biomimicry, defined as the conscious emulation of nature's genius, has been present ever since the human species first interacted and participated with all natural phenomena. Activities such as emulating silk worms, bird's flight, seed transportation or studying ecosystem strategies, and then applying this knowledge to objects, services or communications, is now easier due to the integration of digital databases and the power of visualizing tools that can provide insight on the microscopic or macroscopic level. Biomimicry, as an influential discipline, has started to create multidisciplinary participative networks. Shared interests in the field, and innovative methods arising from this field, are now linking designers, engineers, scientists, philosophers, futurists and entrepreneurs together in a dynamic cross-communication, from the arts to the sciences. This dynamic contributes to the understanding of the intentionality of the human and non-human world, and is leading us to co-design our future.

What if design pedagogy incorporated concepts and experiences into the education of new designers that would explore the creative capacities of non-human beings? What if students were exposed to exploring seeds, shark teeth, the structure of a termite mound, or the interaction of species on the forest floor, instead of being taught about the latest trends in design or looking at iconic designers for inspiration? What if we taught students how to create with Nature, not only as a resource of creative inspiration but also as a comprehensive model of how to live on Earth? These critical questions position Biomimicry as an eco-technique that is central to commencing a transdisciplinary quest to find common ground between biology, ecology and design.

Biomimicry is considered one of the most visionary approaches available to help us to 'address the challenges of humankind' (Porritt, 2007, p. 166). All the species that have evolved over millions of years are survivors, not by themselves, but as a result of all that connects them to one another. In her latest book, *Biomimicry: Innovation inspired by Nature,* Janine Benyus states that these survivors have been 'imaginative by necessity' (ibid, p.2), having already solved the problems that we are struggling to solve. She goes on to assert that we need to look at nature as *model, measure and mentor*[30] in our problem solving. This approach to biomimicry offers a way to relate to other organisms by reflecting on the need for harmony and respect for nature, as well as advancing technologies. We humans need to adapt to nature's needs, not the opposite. This points to another aspect of biomimicry, which is the need to generate efforts to safeguard nature's creations. Such a warning underlines the important role that Biomimicry can play in educating future generations, particularly in developing the way to design *with* and *for* nature.

We are reaching a stage in history where those who generate technological innovations are beginning to revere nature. The realization of the innate intelligence of nature is shifting the way we are generating innovations in the 21st century (Frenay, 2006, p. 65).

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30 See glossary: Nature as Model, Measure and Mentor principles

Rediscovering how the features in nature contribute to the solving of human needs is pushing biomimicry to become a key tool for designing and for our survival. Braungart and McDonough (2009, p. 178), and their debate of 'cradle to cradle', consider designing for biological and technological cycles; for example, mimicking the ways we can redesign vehicles. In the recent documentary titled "*The 11th hour*" (Conners and Conners, 2007), McDonough expands his biomimetic perspective in architecture through comparing the design of a building to a tree, and a city to a forest. Product design mentor Geoff Hollington suggests three technologies that could have a profound impact during the first part of this century: Biomimetic Design followed by Additive Manufacturing and Evolutionary Computation (Sanchez Ruano, 2010, p. 39). He also points out the ways in which the three working together in unison will create a shift from the deterministic, Cartesian, Newtonian, cold, hard, mechanized practice of design, and instead move toward a new heuristic, flexible, participatory and evolutionary way of working. The inclusion of biomimicry is fundamental to the design of objects, services, infrastructure and messages that reflect human biology and ecology, thereby creating a symbiotic world.

Biomimicry can draw together communities of scientists and technologists with designers, to collaborate on forming the intention and framework to move away from the conventional ways of innovation. New materials, robots, architecture, urbanization, 3D printing and computation, manifest a dramatic change and sophistication toward a future where self-organization, digitalization and mobility could potentially offset the current levels of inequity, loss of biodiversity and ethnodiversity, and climate change.

Emerging technologies are also providing ways of translating the wisdom of nature into what is referred to as *synthetic biology*. It is important to recognize the necessity of rational and meaningful responses to the requirements of creative decisions and interventions for the sake of a healthy planet. The intersection of ethics, design and synthetic biology opens the door for new kinds of research that question the influence of biomimicry and potentially harmful practices, such as genetic modification of plants and animals.

In a recent interview, Dayna Baumeister (Eggermont et al., 2013a, p. 59) predicted that biomimicry will play a significant role in the way this century will unfold. She outlines the opportunities we have to reconfigure our existence as a species on this planet. As biomimicry establishes itself in academia and beyond, the design disciplines will in turn face challenges[31] that are more or less external to the discipline. Baumeister explains that our job as biomimics is to apply design principles in a finessed way that is still true to science, but uses our technical expertise to test our best applications of those strategies[32] (ibid, pp. 58–60). Baumeister identifies that the attributes of a good biomimic include humility, honesty, gratitude (for nature) and (scientific) integrity. With all this attributes, we can see that a biomimetic design is able to transmit meanings to the human user and to the natural context in which the user interacts. When non-human cleverness is acknowledged, the ground is ready for the creation of a good natural design.

Biomimicry in design practice implies the use of the principles of life as a tool. It aims to apply the wisdom of diverse disciplines and worldviews in the creation of biomimetic solutions that integrate design, biology and notions of technology. This life-based learning and creative problem solving calls for initiating a new educational and innovative route through design. The intervention of design inspired by natural systems on any form and scale, whether individual devices or complex production systems, requires a critical synthesis of cultural significance, human values, intention, realization and consequences in order to achieve certain levels of sustainability and an ethical understanding.

This chapter concist of a comprehensive review of the literature and includes this researcher's experience of teaching biomimicry as a design method. We can define biomimicry *as a discipline that incorporates the study of forms, systems and processes found in nature to guide innovative solutions to be applied to products, environments, services, messages and meta-systems.* Simply put, it is a tool that can be used to re-design our practices, technologies and behaviors toward a symbiotic condition. Structures, colors, gestures and textures in all biodiversity represent an intention to communicate

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[31] Glossary: Current challenges we face as a society
[32] See glossary: Features that Biomimicry as a practice must integrate

their integration with the biosphere. Design programmes must therefore take into account the mutually beneficial strategies that biodiversity can teach them.

The shift in mimicking non-human design plays a significant role in solving design problems that human societies will face in the foreseeable future. Viewing the world through different lenses (as discussed in the previous chapter), can also help to increase the sense of perception, creativity, emotion and communication of phenomena. If all living beings that create their own designs are to be meaningful and intelligible to us, we need to learn new methods to help us understand these meanings and this intelligence. The biomimetic practices and methodologies that are explored in this chapter suggest tools to *design with nature*, and unravel its geniuses.

There are many ways to explain the evolutionary process of bio-inspired design. Looking at history, one finds many examples of bio-inspired design, from Leonardo da Vinci and his anatomical studies, to the biomorphism embedded in Art Nouveau of the late 19th century, to the sophistication of computation and additive engineering. Every design aims to educate, establish order or change behaviors. Humanity finds itself in an age where there is a need to redirect inventions toward alignment with nature. Undoubtedly, each discipline has a part to play in this process. Biomimicry has the creative potential to make such a transformation. The greatest challenge is to adopt an interdisciplinary approach to understanding Nature's designs and to strengthen and enhance our abilities as designers.

ii. Nature as Design Teacher

The contemporary philosophy of biomimicry is now seen as a guideline for a number of design disciplines. It suggests a kind of innovation that is guided by the collective wisdom of our *anima mundi* – our conscious living planet. Biomimicry can offer solutions to design problems and beyond, and can provide an opportunity for a shift in worldviews, as it compels the designer to learn from nature and to be inspired by non-human beings. It can guide designers to trace the biological roots of a design idea and find ways through which design products or systems can evolve gracefully and organically.

To some extent, most of the infrastructure that humankind has created has been learned from nature, such as the creation of dams by observing the activities of beavers, or registering how plants adapt to the agricultural systems we create. Senosiain (2003), among many others, believes that Nature is a 'great teacher' and its evolutionary journey through millions of years is 'an open source of knowledge'. This humbleness is available to us to learn from, and to innovate, for the benefit of all beings.

Embedding nature's patterns and language into our technologies has become one of the key challenges of our time. Our intuition and experiential needs are biased by sophistication, and the primitive original instructions have been lost in our industrial language. Going forward as a biomimetic society requires a rediscovery of the laws, the rhythmical processes, elegant simplicity, free energy ways and an awe of the wonders of such natural patterns. Such dogmatic ideas of constant flow and reciprocity will set us free and enable us to learn to understand our purpose within nature or within our 'primitive sense', as Schauberger (1999, pp. 29–32) defined. Through his inventions, Schauberger learned that, as humans, we are capable of finding the truth of our creative destruction, and that only exceptional intuition can enable us to understand this challenging wisdom (ibid, p. 34). With this understanding, it becomes fundamental to prepare design students, taking into account intuitive biophilic ways along with biomimicry practices. This is particularly important in order to tackle the difficulties of designing, in a way that will bring truth and purpose to our design culture.

Ecological designers Jack and Nancy Todd point out that the availability of the information that biomimicry provides is ready to be rediscovered. They note that:

> *'The Earth's ecologies are embedded with a set of instructions that we urgently need to decode and employ in the design of human systems. This vast collective intelligence, which evolved over eons, needs to be understood and utilized by human designers addressing all spheres of human society.'* (cited in Wahl, 2006, p. 311)

This vision of design in the 21st century acknowledges a need to integrate the collective living intelligence in our day-to-day lives. Today, we have an opportunity to be inspired by Nature and to become integrated with its processes; we can learn and apply design lessons from nature and use those lessons to create a living infrastructure, products and processes. In the same context, philosopher David Fideler (1997, p. 129) reminds us that the capacity to learn from nature will also enrich our sustainable society. Using the same ideology, evolutionary architect Eugene Tsui (cited in Senosiain, 2003, p. 125) expresses the need to go beyond mimicking nature in order to understand living processes that will free our intentionality. Educationalist John Lane also reminds us of the value of seeing nature as a mentor (Lane, 2003, p. 157). Nature is humble and always open to being rediscovered and reinterpreted.

The concept of biomimicry is expanding, under a variety of synonyms. Contemporary experts from different backgrounds have been questioning and developing the emerging discipline as they incorporate its methods into delivering projects in their particular professional fields. Jane Fulton Suri, from the design and innovation consultancy IDEO, uses the term *bio-inspired design*. She explains that the term means to 'widen the lens through which designers look at the world' (Eggermont et al., 2012a, p. 50). Fulton Suri believes biomimicry can enhance the design epistemology by focusing on the studies of 'how design happens, how designers think and how designers learn', as well as how evaluating the work of biomimicry must fill the criteria of '*elegance, resonance and making sense*.' This notion affirms that, by following the patterns of nature, design reconfigures its epistemology. We are able to adopt an intuitive sense-making approach through biomimetic design.

Engineer Julian Vincent (cited in Eggermont et al., 2012a, p. 24) argues that the objective and critical approach to the science of biomimetics, as he call it, remains a challenge for designers. He believes that designers' lack of concern for science results in an unsatisfactory quality in design products. Nevertheless, he also acknowledges the potential value of designers' entrance into this domain. In a recent interview, design educator Jay Baldwin (Eggermont et al., 2012a, p. 30) expresses concerns that biomimicry is still not a well-known or well-understood discipline and that our biggest challenge is to make it desirable, profitable and useful in society. John Thackara (2006, p. 188), a prominent designer and innovator, suggests that we should focus on the potential of every creature and at the same time interact with technology to make design with purpose when facing the dilemma of innovation. Through these reflections, we notice the need to go beyond conventional ways of approaching design by referring to 'designing with nature' for a better understanding of the sources of inspiration.

Advocates of the discipline of biomimicry believe that learning 'from' nature is perhaps taking our species to this particular stage in the history of our planet. If plants, animals and ecosystems are our teachers, what are their lessons, and how might we become better design students by learning from them? Who will guide us to live sustainably in this world? Looking into nature for guidance suggests developing educational methods that encourage designers to rediscover nature.

Such an ability is perhaps shared with other species. We have been learning from them and they have been learning from us. This dynamic, and the constantly evolving relationship, can be considered as learning 'with-in' nature. As humans, we first learned **from nature** to adapt; we then learned **about nature** to describe our own species; and now, we are trying to learn **with-in nature** to live symbiotically. The more we understand about symbiotic biomimicry in design, the more we will be able to see nature as the ultimate design mentor.

iii. The value to learn with nature and the biophilic connection

By learning biomimicry, design theorist Adelheid Fischer describes the way she gained a kingship with life. Her previous biophilic encounters revealed that, 'We are never alone, never strangers, in the world' (Eggermont et al., 2012b, pp. 36–37). With this reflection, we can see how biomimicry and biophilia complement each other; both concepts aim to create pathways of 'learning with-in nature' that our world urgently requires.

Teaching how to interrelate these concepts is also vital in understanding our creative natural intentionality. Biomimicry, and its impact on the development of technology that can be embedded in crafts, architecture and even services, should be questioned and guided by biophilic values. Understanding how we relate to the world and being open to reading the patterns of nature is a matter of understanding biophilia.

Introducing biomimicry at the beginning of the design process can open up possibilities to achieve the ecological understanding that contemporary designers require. As the internal need of being in balance with nature is satisfied in the designer through biophilia, the external projection, which is the design outcome, will also be in tune with the natural world through biomimicry. The idea of linking the concepts of biophilia and biomimicry aims to support the notion of co-creation with nature.

Stairs (1997) identifies the way that biophilia and, to some extent the technophilia that design has introduced, creates an intentional evolution. The basis of this intentionality cannot only be generated through the ethical approach of biophilia; it also needs to include biomimicry in order to reach a deeper understanding of life's dynamics when generating aesthetic values. In this regard, Lucchesi (cited in Eggermont et al., 2014a, p. 89) also suggests the need for integration of biomimicry with biophilia. Through this integration, biomimicry can transcend from nature-inspired design to design that is in harmony and collaboration with, and within, nature. This interrelation with both concepts can expose the idea of the 'it' of integral theory; in other words, the relational individual self with the real world.

Biomimetic design practice that goes beyond unlocking innovative capacities in the process of problem solving encourages us to look for stronger connections with our natural world. Taking the ecological path, there is room for designers to rethink the constitution of materials, the use of energy, self-organizational processes, regeneration and biodegradation cycles.

Biomimetic design can give us the tools to create, but it can also gives us the tools to destroy life if taken to the extreme. Being aware of these two dimensions, we are encouraged to produce ethical behavior. Mediating nature solely through biomimetic design may turn our understanding of nature as something external to us, to something artificial. It is therefore necessary to establish Biophilia as an initial stage of understating nature, purposefully connected through the Biomimicry ontology.

By being conscious of our biophilia, and by truly sensing what surrounds us, we can enable our biomimetic vision to develop. Using our biomimetic lens, we are able to comprehend the beauty and the creativity of the world outside and within us. The creativity that exists around us reveals the efficient and transparent beauty. The challenge is set. Education needs to prepare future generations to see both dimensions, one that reconnects with nature, but also one that helps to rediscover, live and learn from the patterns of nature.

iv. Nature-Artifice: Between superficial and deeper meaning

We are able to raise some objections to the ethics of biomimicry in order to bring new skills to identify unnatural designs. Reichmann (2006, pp. 213–232) argues that nostalgia makes us want to reconnect with nature through Biomimicry, and that this can affect the notion of artifice as it lacks coherence, even though it hasgood intentions. Indeed, reviewing the history of design can be a good exercise in uncovering failures of contemporary designs that were based on 'natural history'. Regarding this concern, Reichmann examines the writings of architect Lewis Mumford and his reflection on the contracts between mechanical and organic technology:

> *'We have reached a point in perfecting the same technology that organic has begun to dominate the machine. Instead of simplifying the organic (...), we have begun to complicate the mechanical, in order to make it more organic; therefore, more effective and more harmonious with our living environment (...) We understand now that the machines, in the best case, are imperfect counterfeits of living organisms. Our best airplanes are rough approximations and uncertain when compared to a duck in flight; our best electric lamps cannot be compared in efficiency with the light of a firefly; our automated phone system is a complicated child artifact when compared with the nervous system of the human body."*
> *(Mumford in 1934)*

Denoting those comparisons and metaphors of what we call artifice, through biomimicry, we begin to move away from the notion of artificial versus natural. Biomimicry is a state of nature-artifice notion that helps us to redirect our intentionality and intelligence toward a critical dialectic art. As we reach a natural path for designing, our cognitive process (ideas) and ethical creation (ends of ideas) will thrive as a life process. If we understand the dynamism of biomimetic design as an eco-technique, we will be able to discard artificial things that do not enliven our world.

Intention is an entirely human attribute, and objects are not generated unless with an intentional artificial process (Pacheco Esparza, 2013, p. 20). Becoming aware of natural processes and learning about requirements of the artifice leads us toward a kind of creative intentionality, which provides us with the ability to guide our human processes close to the non-human process, without undermining the technological progress we have achieved so far.

When the designer reaches the conceptualization of a biomimetic design, it triggers the ethical inquiry between intention and awareness, and determines whether we actualize, reshape or discard the idea. We humans have maintained our ingenuity through a constant exercise of adaptation, mitigation or transcendence (Ruse, 2004) (Hingston et al., 2008). The creative activity we call design that has emerged since we began to consciously hold objects and reconfigure or combine them (i.e. the axe), is an intrinsic response to our ever-changing environment and bodies. Using objects as the extension of the body in order to satisfy basic needs is what made us human, and creative. The epistemology of biomimicry has been embedded in the process of mimicking nature since ancient times. We must consider this in relation to the way we create 'artifice' through designing the process of life itself.

The notion of *Autopoiesis* then becomes a reference to assess the effectiveness of biomimicry in design. *Autopoiesis* refers to the replication of regular loops of information in nature (Rumesin and Varela, 1992). Maturana and Varela suggest that there is a self-perpetuating and self-generating mechanism that is replicated in larger networks of life. By emulating and being inspired by nature, designers can apply deliberate ornamentation or abstraction, an action that could be interpreted as artificial. We are able to question the origin of the artifice, or where the purpose of its natural gesture lies. Shallow biomimicry can represent objects that reflect the language of nature, but may become hyper artificial or prosthetic (Morton, 2013). The natural element can gradually vanish, causing fragmentation of values and meaning.

Biomimicry, and its natural-artificial duality, is an ever-present questioning of the enhancement or reciprocity for life. For example, in using the eye of a fly as a model for the design of a new camera, designers might be inclined to copy the forms and shapes to create a design prototype. However, through biomimicry methods integrated with biophilic understanding, designers can also take into consideration the context in which the fly lives and acknowledge the relationship between humans and flies, leading to exploring the possibility of creating a new device with the features of a fly. As artifice becomes more attuned with natural dynamics, we will be able to study new technological habits aimed at generating less impact (ethics), and more health and beauty (aesthetics). Through Biomimicry, if taught according with ethical and aesthetic morals, perhaps we will be able to break the boundaries of anthropocentric artifice.

The following section presents historical examples and data that show that the language of nature has existed in everyday life; nevertheless, it needs to be remembered through methods that can uncover the patterns connecting the natural design to human life. It also discusses the literature that design practitioners need to know when they begin to *ideate with nature*.

4.1.1 Ideate with Nature: Between inspiration and meaningful aethetics

How important are aesthetics in relation to biomimicry? The answers to this question comes perhaps from historical facts; for example,the uncouncious mimicking of nature carried out over the centuries by craftmakers and schools that taught in vernacular styles. For generations, naturalistic or abstract forms were used in ornaments and artefacts to symbolize how we perceive the world around us. Consequently, in this designing 'with' nature there exists a paradox, in which lies not only the aesthetic but also the ethical dimensions.

Foster (cited in Kelly, 1998, p. 339) explains that Plotinus believed that imitating the beauty of nature transcends aesthetics, delivering beautiful acts that fulfil the spirit and inspire self-love. Through imitating nature, he describes how Aristotle found fascination in the capriciousness of natural or life forces, and how Kant referred to 'environmental art' as the product of 'intentional agency' that follows the ancestry of natural form s or processes and leads the artist toward making adjustments of the artistic yearning to for communion with the Earth. Thaking this perspective into account, bio-inspired design is an expression of that yearning for identifying ourselves with our living pla net through every physical act, acts that are rectified beyond formal-aesthetic mimesis of nature.

Decorations, ornaments or artifice, which have appeared in every culture since ancient times, are symbolic expressions of an inherent need to replicate the natural world. Cave paintings, body decoration, textiles, facades and columns as found in indigenous communities and the remains of ancient civilizations, represent the aesthetic expression of the human species that make evidet their communion with other species. Such ways of appreciating nature were absorbed by our senses and manifested in simple objects made to respond 'in place' to our needs; humans achieved this by utilizing pure intuition. This way of responding to nature created the same sensory attraction that represented itself as the need to replicate natural textures, colors or birdsongs, to mentio n a few examples. The desire for aesthetic replication of nature was, for primitive humans, mainly a means of finding comfort and pleasure in objects with patterns that were familiar to our human senses and that made us participants with-in the natural world.

The life force of aesthetics is connected to the sensible intelligence of living beings. The joy and sensual appeal of natural things is a starting point in designing. 'All is sense-catching [*sinnenfallig*]' (Seel cited in Kelly, 1998, pp. 341–343). Seel argues that we have to pay attention to the freedom of nature in order to 'liberate through their own gestalt', and not create a style. This means that we shoud look for intentional mimicking of the world. Biomimetic design is, then, a gradual development of human culture. When examining Seel's approach (ibid), we can distinguish the following important statements:

> *'We keep destroying this sense of nature's beauty by separating our human design from the relational attractiveness of nature [...] such independence is caused by the unguided fullness of the appearances it presents to our senses.'*

> *'The aesthetics of nature is simultaneously part of the ethics of the individual conduct of life. It enlightens us on a genuine possibility of good life.'*

We need to realize that not everything is human work, not everything is of human design and not everything has a stated meaning. Experience of nature's beauty is fundamentally positive. It is interesting to note that maintaining distance to human designs and human responses tonature can be considered beauty. Projections of natural beauty in human culture show the undeniable presence of nature in human life and the key role that plays in our happiness. Acknowledging the beauty in nature is not a means to achieving happiness; it is a form of happiness itself. Simirarly, we cannot correct nature by design; nature is free, with its own design. This is a fact that needs to be taught, but it should also be considererd common sense that nature's aesthetics be integrated with ethics.

Expanding on this topic, Powers (1999, p. 15) points to the Greek architecture that follows the principles of nature as a perfect means to engage with the world, and how such awareness of nature transcended the Renaissance beyond the symbolic, religious and magical. He also suggests that the natural history of design is reaching a 'post-Cartesian age' (ibid, p. 26), where we are shifting toward a more sensuous understanding in order to learn from nature and what connects to emotions and sense-making.

Natural design must aspire to be alive. Colors, textures, materials and ornaments must express the characteristic of an unfinished Nature that encourages inspiration and creativity. Expanding on the idea of abstraction, we can refer to the way in which makers respond to material needs, by keeping a sacred dimension of nature in order to ignite a participation with the cyclical rhythms of nature, and how they reflect on the cosmology of nature (Keeble cited in Powers, 1999, p. 26). Biomimetic design can unknowingly become a luxury with no meanings. It is therefore necessary to include ethics in bio-inspired productions, constructions or services, in order to evaluate their conformity with or contrast to the well-being of humans 'in' nature. Sensing this aesthetic, then, must be intuitive and truly felt.

As we acknowledge how design changes over time, as we acknowledge how design changes over time we are able to detect a natural historyof nature's own designs. In the same way that we looked for answers to understand the world through the natural sciences, Biomimicry fosters the creation and replication of beauty around us. Regarding the notion of beauty, Postrel (2009) argues that aesthetic 'is not a luxury, but a universal human desire'. On this premise, Biomimicry should be an engine to foster beauty. If the desire is a driving force of evolution (Hosey, 2012), then the practice of biomimicry can be a driving force of creativity. Biomimicry goes beyond art or scientific exploration; it is a poetic act with meaning, and is something that can reflect ethics and aesthetics at the same time, in relation to human and non-human design. This kind of intention that biomimicry promotes transcends to reach nature's design and desire, and is a route that will lead us to a *bio-synergy* (Mathews, 2011).

Snowy mountains, flowing rivers, fast hummingbirds, trees that change with the seasons, coral reefs blooming; these are just a few examples that portray a unique and healthy beauty, ready to be rediscovered as part of the biomimetic design of the Earth. Human ingenuity is always looking to gain value from, and to nurture, the natural world and, if we pursue this continuously interacting aesthetic-health process, a co-evolutionary process will be ready to be implemented through design. Today, we must be attentive to become part of nature's dynamic.

If all living beings are at the highest level of biological evolution, as we believe as humans to be, we all stand at the same level. However, the complexity of the world is increasing and we, along with other living beings, are determined to survive in it. By recognizing the aesthetics and maintaining healthy interactions with other beings, we will be able to find better ways of adapting and thriving together. Botkin (2000) put forth his notion of co-designthat focuses on the need to explore beyond the physical aesthetics of Nature, and inquiries into the 'whys' of the emergence of forms, materials and their relationship with our technologies. Posing such inquiries turns biomimicry into a tool used to generate innovation that we are always continuously seeking to reach.

It is important to recognize that, beyond physical appearance – starting from the simplest bacteria to the most sophisticated mammal – there exists an aspiration for a continuous life balance that maintains with the same solar energy, planetary gravity and organic and inorganic cycles. These are all the same 'formative processes' (Wahl, 2006, p. 41) that humans and non-humans require in order to thrive. It is in the same perpetual aesthetic dance that objects, built environments, messages or services must follow. Such an understanding must incorporate design to contextualize the way we follow the patterns of nature, in order to move forward planetary symbiosis.

Many designers and theorists have explored the meaning of nature's inspired aesthetic. For example, Buckminster Fuller (1978) comments that Mother Earth is like a spaceship that did not come with an operating manual. This clearly demonstrates the need for developing a symbiotic language. William Morris, one of the great pioneers of design, similarly expressed his commitment to the pursuit of beauty. Referring to Morris' work, Tiezzi (2001) points out that, in his time, the beauty of history was in crisis; this is in contrast with the present day notion that maintaining the beauty of our world is an issue of salvation. He goes on to say that for Morris, the battle was against industrialization, whereas today it is against artificiality and consumerism. Is biomimicry, then, the answer to generating or rescuing this aesthetic? Designers may be able to answer this question by engaging in the study of natural processes, from which they can not only find inspiration and generate innovation, but can also recognize our human capacity in the *organic progression* of our bioculture. This is where objects or buildings, as extensions of humankind, can be an inherent part of the biological dynamics captured in design.

Gregory Bateson, a pioneer of cybernetics in his book *Mind and Nature* (2002), illustrates the idea of spirit (or mind) as something that not only belongs to humankind, but is a common feature in all forms of life and many manifestations of matter. Bateson's philosophy underlines the aesthetics and the ethics that we need to acquire as biomimetic practitioners. Our human accomplishments need a reconstitution of our natural purpose: seeing the image of nature in what we create. But what is the true image of what we are? Irwin (2004, p. 135) answers this question with another question:

> *'If someone ask me why designers should study natural form or why the meaning of the form is relevant? I will answer: if we understand the meaning it is because it expresses to us how to live. It shows us how graceful, efficient, beautiful and cooperative it can be as we come into the world, and in the same way as we leave. If we identify the meaning of the forms we can learn how to move from dissonance to resonance. The Natural form is 'like being in the world' and that is there to learn.'*

In response to a similar design question, Botkin expresses how we can engineer Nature in 'its own proportion and in its own way' (cited in Gruen and Jamieson, 1994, p. 32). In this researcher's opinion, this dynamic should be the task of future design disciplines, an intention of maintaining the kind of biological epistemology that can be expressed through biomimetic design. It is in the same way that we see beauty in the patterns of

relationships with nature, that we translate them into our human ethics. Emulating the beauty of life should involve embracing its freedom and leaving behind the cold, mechanistic and deterministic ways of designing. It is important to teach future generations to partake in promoting the beauty of reflecting our humanity-within-nature.
We are increasingly understanding the cleverness and grace of the patterns of nature. Beauty should be a keyword for biomimetic design. Beauty 'is the open source, which unleashes the awe bordering on reverence, the humility and the spirituality that are now needed for the survival of our civilization' (Lane, 2003, p. 157). More than a mere style, biomimicry is able to create an aesthetic lifestyle; it replicates nature's wisdom.

Education theorist Rudolf Steiner (cited in Powers, 1999, p. 41) believed that the spirit of nature will soon reach an epoch of aesthetic pleasure where 'cleverness without morality will be non-existent'. He suggested that nature will conduct us to 'deteriorate our mental abilities' to understand morality and intellect. Steiner was optimistic about humankind's aspiration to learn from nature and to move toward cultural transformation. Such notions are relevant to the field of education, in which biomimicry must be present to be an advocate of the truth and beauty of the Earth; it is, therefore, necessary to demand and question the action of biomimicry toward the creation of a new ethical aesthetic. In this regard, we can recall Prigann (cited Wahl, 2006, p. 300) on his ecological based aesthetic: 'It is not ecology that needs an aesthetic treatment, instead the aesthetic follow ecological insights. Nature does not need an aesthetic domestication.'

These perspectives on ethics and aesthetics also suggest that we need to integrate multidisciplinary views on the eco-technique that is biomimicry. Promoting the aesthetics of nature to fit in symbiosis will help us to find ways to appreciate forms, but also to follow the clues that we ought to embed in our bioculture. Following clues and hints from nature is perhaps the bio-inspiration that the biomimetic practitioner seeks. As we create artefacts and technology to observe, analyze, synthetize and measure nature, we are able to rediscover our own ways of being a species, and at the same time of accepting ways of life of our fellow species.

Nature is a repository of intelligence, which design and other disciplines can translate. By transcending our perception of nature we, as a symbiotic species, can consciously achieve innovation in design in surprising ways. To be able to read the operating instructions of nature, and to generate aesthetics and ethics in relationships and interactions, it is important to be open to letting nature teach us its reasons for beauty and crudeness. Such pusture then places biomimicry, and recognizes biophilic values, as reverential qualities that can be encountered by studying the patterns of life. As we find such patterns, we also find love, affection and devotion in every non-human design.

If technology, transformation, consuming and digitalization are some of the factors that are conducting our relationship with the world, we must find and apply such language and instructions on the design of everyday life. The way in which biomimicry is helping us to comprehend and value the richness of patterns and strategies found in nature can be understood as a tool to adapting our artificiality toward sustainable practices. Nevertheless, biomimicry doesn't create sustainability by default. Beyond inspiration of forms, processes or functions, we require ethical designers that embed meaning. Changing our perception of how we need to be, *in service for the world and projecting beauty,* are some of the philosophical principles that we are able to recognize as biomimetic practitioners, which can lead to us toward reaching such an important state.

4.1.1.1 Inspiring biomimetic practices

a. Lessons from the past: A Bio-inspired history

The term bio-inspiration was first proposed in 1964 by Fromm (2011). He used the term to refer to the act of searching for a connection between humans and other life forms. In this research, the term is used to describe the idea of rediscovering virtues of nature by exploring historical examples of the evolution of design.

It would be absurd to believe biomimicry is a newly emerging practice. Throughout history, human ingenuity has found inspiration in nature for the production of new materials, creating algorithms, the construction of infrastructure and, of course, the efficiency applied to objects, tools and mechanisms. Emulation of nature has been intrinsic to human life as a way of adapting and comprehending their home, the Earth.

We can find clues to human ingenuity influenced by natural inspiration in mythology; for example, Daedalous building a pair of wings to escape from Crete represents this idea of emulating nature. There are historical examples of technical innovation, which some experts on the subject consider to be the origins of biomimetics. Vincent points to the example of the Chinese culture's attempt to imitate the *Bombyx Mory* larvae to produce artificial silk 3000 years ago (cited in Sanchez Ruano, 2010, p. 52). Another piece of evidence is one of the documents written in 400 BC by Democritus, in which he has elegantly written:

> '*We are pupils of the animals in the most important things: we become the spider's apprentices in learning the craft of weaving, we learn from the swallow to build houses, and from the nightingale and swan, for singing, by way of imitation*.'

One of the first registered biomimetic applications is found in the drawings of Leonardo da Vinci (1452-1519), from the 15th century. Da Vinci based many of his studies on understanding how bats and birds fly. His sketches of animal and human anatomy in relation to flying machines are considered to be one of the first human attempts to imitate the flight of birds. Da Vinci illustrated the growth of animals and plants, human anatomy and the flow of minerals in many of his geometrical studies. In his work, we can observe how art and science was merged. During the Renaissance – book production, trade and naturalism began to emerge, facilitating ways of exchanging ideas about the world.

With the end of the Renaissance, the spread of information and the need to communicate with different cultures in order to observe and measure, and the division between the study of body and mind, ignited what we now refer to as the Cartesian thought. Exploring new ways of discovering and creating is what we define now as 'method'. Rene Descartes (1596-1650), inspired by Greek philosophers such as Plato, introduced a kind of philosophy that confined reality to what is measurable. In this period, mathematical calculations, geometry and measurements were employed in the creation of beauty in certain ways, but they also created fragmentation by separating what is in the mind and what is out in the world, a worldview that remains part of our contemporary thought.

In the 16th and 17th centuries, Baroque and Rococo styles introduced the allegory of the irregular and ever ephemeral Nature that we wanted to control. The influence of Catholicism and the possibility of trading techniques from around the world brought forth the picture of 'Heaven on Earth', represented by plant and animal structures carved and painted in altars, fountains, rooftops and wood furniture throughout Europe and the Americas (Sanchez Ruano, 2010). Machines, money and labour started to create alienation and placed the notion of nature as something external, out there, at our service. Another aspect was urbanization; moving from small villages to cities created a yearning that artists and poets began to express in their writings, art works and craft objects (Skrine, 1979). Human culture began to make a division between nature and the self by extracting, consuming and not reciprocating what was given by nature (Porter, 1997).

It was not until the 19th century that the emerging field of the Natural Sciences prompted a reconsideration of the ways of seeing nature and the dogma of Nature as subject/object. At that time, the theory of the evolution of species altered the concept of creation. Charles Darwin's work laid the foundation for scientists to commence the research and objective exploration of Nature. This led to social attitudes that increasingly questioned survival, and the domination of nature grew rapidly. During that time, being a natural scientist was also considered as an artistic vocation. Devices were developed, such as microscopes, a feature that demonstrates how human ingenuity and technology was necessary to understand the world. Campi (cited in Sanchez Ruano, 2010, p. 58) identifies that, throughout this century, 'the exercise of the natural sciences was widespread among the intellectual classes and their publications. Architects, artists and designers came to specialize in botany or zoology'. The natural world represented an inexhaustible source of inspiration that could be expressed in arts and crafts. Similarly, books with naturalist contents that inspired the applied arts started to emerge expressing the notion of *biotechnic*. One of the fascinating examples is Reverend John George Wood (1827-1889), whose works illustrates the connection and understanding of animals and plants as inventors. "*Home without Hands*" (1875) and "*Nature's Teachings: Human Invention Anticipated by Nature*" (1877) display a collection of analogies that are not far from the kind of investigations that the biomimetic practitioner conducts. The evidence and knowledge that Wood intended to bring to the general public was with the aim to describe the 'parallels between nature and art'. As an unintentional design naturalist, Wood (ibid) stated:

> *'in Nature lies the prototypes of inventions not yet revealed to man, and how the great discoverers of the future will, therefore, be those who look to Nature for Art, Science or Mechanics, instead of taking pride in some new invention, and then finding that it has existed in Nature for countless centuries.'*

When industrialization emerged at the end of the 19th century, it completely alienated the notion of a connection with nature, yet it also gave rise to the nostalgia of losing nature. For William Morris (1834-1896), nature was present in every creation; his fabrics, furniture and wallpapers demonstrated his sensitivity to nature and his pursuit of quality in life, by using design. He is now considered one of the early ecologists; Morris believed that 'a system that destroyed nature must ultimately destroy itself' (cited in Powers, 1999, p. 55), which in principle was a critique against the new urban development in England. The Arts and Crafts movement that he ignited represented the truth of nature, epitomized in the noble exercise of artisanal production.

During the Industrial Revolution of the 19th century, exchanging technology and ideas with other cultures proliferated. International trade shows and exhibitions displayed and shared technologies, along with the richness and diversity of other regions. The display of crafts, animals, plant species and new inventions became common. One of the most well-known of those was the Great Exhibition at Hyde Park in London in 1851, where the magnificent Crystal Palace and its construction now represents a work of bio-architecture. The botanist and designer of this greenhouse-like building, Joseph Paxton (1806-1865), studied the structure of the Amazonian water lily. He was inspired by the ribbed pattern of the rounded leaves to design the metal skeleton that made up the domes of the building. Another example from this period is the Wright brothers' invention of the flying machine. They studied birds and used bicycles in their invention; they studied vultures to perfect the design and landing of their flying machine.

From the second half of the 19th century, natural scientists and designers expressed more sensibility about the forms of nature. The study of natural phenomena and the exchange of techniques of industrial production were present in the ornaments of furniture, architecture and textiles. Such ornamentation gained a new dignity, since it was no longer viewed as a superficial add-on. It was exposed as a dimension that structured nature. The Art Nouveau movement, which emerged toward the end of the 19th century, was characterized as a form of art that represented vegetal and animal motifs and organisms found in the asymmetric growth of flower stalks, buds, vine tendrils, insect wings and marine animals. Architect Rene Binet (1866-1911) was a naturalist whose works were inspired by the biological science of the time. His *Equissses Decoratives (n.d)* explores the principles of physiology and morphology that Biologist Ernst Haeckel (1834-1919) studied using the microscope. One of the great examples of the movement was Binet's *Porte Monumentale,* the building design for the World Faire held in Paris in 1900. Inspired by Ernst Haeckel's lithographs of microscopic biomineral creatures, Binet designed amoeboid facades, protozoic trellises and heliozoic motifs. The family of radiolarian, known as *Cyrtoidea,* inspired the design of this gate (Breidbach and Proctor, 2007). For the 'educated' society at the beginning of the 20th century, nature was meant to dominated; it was seen as a new kind naturalness or something to be accessed to be experienced or studied in academia, or visit at the zoo (ibid, p. 28).The example of works by architect Rene Binet and his ornaments, inspired through exploring the morphological studies of biologists Ernst Haeckel, represent a historical documentation of how the scientific interdisciplinary ignited innovation; indeed, Binet and Haeckel exchanged correspondence to discuss their amusement. The explorations offered by Haeckel and other natural scientists of the time, manifested the idea of a 'new naturalness' of their own reflected culture, which made nature valuable as a cultural commodity (ibid, p. 29).

Expanding on the importance of Art Nouveau for Biomimicry, Paul Greenhalgh (2000), in his book *Art Nouveau: 1989-1914*, describes four strategies on the disposition of natural form in objects or buildings: Pantheism (realistic detailed reproductions), symbolic conventionalization (tame nature by abstracting and hindering practical functions), metamorphosis (poetic transformations or unfinished works) and evolutionism (as in Darwinism, unstable and in constant change).This new interpretation of nature is seen in jewellery and glass pieces of Rene Lalique (1860-1945). Learning the strategy of Art Nouveau was spread through the use of ornamentation manuals.

The constructions of Spanish architect Antonio Gaudi (1852-1926) are further expressions of the movement. His designs were influenced by marine elements, crystal formations and bones used as symbolic or structural features. The examples of his designs are Casa Mila, Casa Batllo and the Sagrada Familia Cathedral in Barcelona. Gaudi found solutions, not in conventional books, but in the 'book of nature', as he expressed it (cited in Sanchez Ruano, 2010, p. 58). In Gaudi's work, we can see an example of the individual who becomes inspired by nature and transcends it by applying its properties to functional structures. The application of geometry and structural engineering in his buildings expresses the aesthetic and functional effects of nature's principles that the place dictates. The influence of the Art Nouveau movement reached industrial production and application of technologies at the beginning of the 20th century. The term *biodesign* (Greenhalgh, 2000) began to emerge, representing the elegance, romanticism and lightness integrated in metro entrances, window frames, bakelite radios and many other technological elements, aimed at participating in the culture of mimicking and integrating nature.

It was in the first decades of the 20th century that the naturalist D'Arcy Thompson (1860-1948) first studied natural patterns to facilitate mathematical understanding of nature's physiology. He aimed to understand 'forms as a diagram of forces'. In his book *On growth and form* (Thompson, 1917), he described how A. Gustave Eiffel (1832-1923) designed the Eiffel tower using mathematical calculations and the study of the human bone, as well as the studies facilitated by anatomist George Hermann von Mayer (1815-1892) and engineer Karl Culmann (1821-1881), through analysing the trabeculae bone and the cellulous interior structure.

The Art Deco style (1925-1940) favoured geometry and dismissed complicated organic form. It brought simplicity to ornamentation. Such reductionism certainly did not abandon the notion of designing with nature. Louis Sullivan's (1856-1924) stylized skyscrapers, or Charles Rennie Mackintosh (1868-1928) interiors, followed the philosophy of 'form follows function' that encouraged the relationship between nature and the emerging relationship with modern manufacturing processes (Powers, 1999, p. 21). One of Mackintosh's followers, Frank Lloyd Wright (1867-1959), proclaimed an affinity with nature, appropriating the term of organic architecture. He on countless occasions found inspiration in the natural world. He described the saguaro cactus as 'a perfect example of reinforced construction (...) a real building with an effective economy, functionality and aesthetic' (cited in Sanchez Ruano, 2010, p. 58). During the first decades of the 20th century, the Bauhaus also appeared on the map of design schools. It redefined the concept of design and linked it to education. This aspect will be discussed in the next section.

This small selection of bioinspired examples throughout history represent the role and value of being inspired by the forms, textures, rhythm, asymmetry and evolution that attracted the attention of artists, craftsmen and scientists. Today, it is important to study these examples as biomimetic practices.

b. Why biomimicry now? A renaissance of a bio-technic

Learning from nature, and consciously translating it into everyday life, led to style evolving over the 20th century. The predisposition and specialization of disciplines led to the emergence of a variety of the terms that could be considered synonyms. Depending on the audience or the technical language that is used, different terms such as: biodesign, biocybernetics, bionics, biomimetics, biomimicry, or biologically inspired design, are applied and all refer to the techniques of learning from nature.

In the 1920's,the potential of bio-techniques was unintentionally reconfigured by the new design academia regarding the industrial responses to nature. This is illustrated through the history of the Bauhaus school. Design pioneers and educators in the Bauhaus, Walter Groupius (1883-1969), Johannes Itten (1888-1967) and Laszlo Moholy-Naggy (1895-1946), introduced contrasting ideas regarding nature's forms and traditional crafts. The Bauhaus and their teachers did not abandoned the idealistic notion of generating social well-being by linking nature and human creativity; they were aware of the gradual domination of the mechanical methods. Johannes Itten, the new-age master, put his focus on exploring organic creativity through awakening the sensitivity to nature in the human body. Lazslo Moholy-Nagy, an artist and photographer, believed that design should follow 'laws of life which guarantee an organic development' (cited in Powers, 1999, p. 23). Inspired by the botanist/microbiologist Raoul Heinrich Francé, Moholy-Nagy developed ideas on social responsibility (Anker, 2005) and he also embraced an ethical approach at the New Bauhaus, offering to future generations of students an alternative perspective on how society could 'live in harmony with nature'. The ideas of a *bio-technique* learned from Francé, encouraged Moholy-Nagy to incorporate natural science literature in his research to make his students 'aware of the fundamental biological needs of the human society' and to use 'an organic approach' in design (ibid p .234).

The influence of the New Bauhaus in promoting welfare and bio-techniques influenced the design of some animal houses at London Zoo and on housing in the Tennessee Valley in the USA, which were instigated by evolutionary biologist Julian Huxley (1887-1975), a friend of Moholy-Nagy. Huxley co-authored the book titled "*The science of life*", along with science fiction writer H.G Wells (1866-1946). This book is a collection of examples from biologically inspired design, with an emphasis on behaviorism, Jungian psychology and morality (Anker, 2005). Such a view on the human place in nature were partly influenced by Julian's grandfather, naturalist Henry Tomas Huxley, a friend of Charles Darwin and a follower of the ideas of the theory of evolution, and were reinforced by Moholy-Nagy's ideas of bio-technique. As a group of friends, they collaborated in producing the film entitled "*Things to Come*", in which Moholy-Nagy collaborated as the set designer and H.G Wells as the writer. Filmed in the 1930s, the story manifested a utopian society based on ecological ideas and a mystic communion with technology (Anker, 2005). The story of these pioneers suggests a reintroduction of a kind of mysticism in the design of our future technologies and cities, using nature as the model for human inventions, a dimension which was gradually lost and scarcely applied in the design pedagogy of the 20th century.

Other publications from this period demonstrated the curiosity of the time regarding scientific data and the value of the appreciation of nature as a source of inspiration for technological and design ingenuity: William Paley's *Natural Theology* (1809); J. Bell Pettigrew's Design in Nature (1908); Maurice Maeterlinck's *L'Intelligence des Fleurs (1907)*; Henry Coupin's *The wonders of Animal ingenuity (1910)*; Patrick Geddes' *Cities in Evolution* (1915); Raoul Francé's *Plants as Inventors* (*Die Pflänze als Erfinder)* (1920); and, Laszlo Moholy-Nagy's *New Vision* (1938), are some of the outstanding publications of the time on biomimicry that show how the concept of biomimetics was formed and developed by the intellectual exchange of ideas.

During the 1930s, Moholy-Nagy contributed with '*A Note on Biotechnics'*, discussing perfection, progress and evolution on the analogy between biology and technology, calling for a method of research and the results a 'biotechnique' (Steadman, 2008, p. 156). Moholy-Nagy believed that, while in the design of machines people have often hit accidentally on solutions which have turned out subsequently to have precedents in nature, it may still be possible to devise organic solutions which have no such natural prototypes. Another important contemporary publication that Steadman (ibid) mentions is the one by architect Frederick Kiesler, who also extensively researched the development of biological analogies and discussed it in an article titled '*On Correalism and Biotechnique*' (1939). Discussing the notion of 'biotechnique', Kiesler argued that in the production of objects, we need to question the form and its meaning and function that move beyond mere aesthetic.

Patrick Geddes (1854-1932) similarly defined biotechnic as 'nature's method of building, not...man's.' He defined the importance of identifying a new need and the emergence of new types or evolved artefacts. Geddes's book on planning, *Cities in Evolution* (1915), introduced the terms 'paleotechnic' and 'neotechnic' to categorise successive ages in technological history. Palaeotechnic referred to the crude, primitive and wasteful phase of the Industrial Revolution, and neotechnic to an emerging industrial order conducive to health, beauty and harmony with the natural environment. Later, Lewis Mumford (1895-1990) revisited Geddes's idea on the notion of biotechnical design to simplify urban living. Mumford's argument involved economics and politics in design, moving from massive monumental infrastructures to low, small-scale, open and decentralized alternatives. This technical history, recognized as 'biotechnic', made a shift to the idea of progress and engineering and led to the emergence of cybernetics. Steadman (2008, pp. 158–161) identifies how this 'biotechnical' enterprise continued after the Second World

War under several names and on a much more scientific basis.

The Styling, the new aesthetic technique of the 1950s, involved a 'streamlined' form which incorporated an array of biomorphism. It was born out of the aerodynamic studies of automobiles, jets and space vehicles. Such sophistication excited consumers and these features were widely applied in the design of house commodities. Water drops, birds and marine creatures were the main sources of inspiration for creating efficiency and velocity. During that time, *Cybernetics* was one of the first concepts that drew together biological and technical knowledge. As described by Litinetski, this mid-20th century science established a unique framework for the study of the direction and organization processes found in the animal world used to inform mechanical systems. Litinetski (1975, p. 25) describes Cybernetics, originally put forth by Norbert Wiener (1894-1964), as 'the science of control and communication in the animal and the machine'. This term delivered an understanding of complexity, which the biologist started to interpret and the engineer implemented.

The fields of automation, telemechanics, radio-electronics, communication and computation were prompted to include the study of living nature to find ideas and means to solve technical problems. Bionics, as a cross-disciplinary concept, explored living systems in order to perfect instruments, machines, energy flow and building construction. It emerged as a systemized study of those biological mechanisms that promise to have practical applicability in man-made devices (Gerardin, 1968). Fabricio Van den Broek (2000) indicates that early definitions of bionics excluded the study of minerals, which contain principles of great interest (such as self-regulation, development, cycles etc.) that feature in organic systems. At the middle of the 20th century, the military doctor Jack E. Steele (1924-2009) defined bionics as a field of study that looks to copy real human organs in the design of medical prostheses – artificial limbs, heart pacemakers, cochlear implants – and move beyond these to cybernetics and anthropomorphic robot design.

Cybernetics, along with bionics, were mainly used in the military. There are many examples of this, including the development of camouflage, inspired by animal mimicry, in areas of high vulnerability to predators, smoke screens inspired by squid that release substances to evade predators, the study of cetaceans and sonar bats for echolocation and radar. The term biomimetics also appeared in the 1960s; Otto Schmitt (1913-1998) suggested a wider focus beyond the medical and robotic-electronics.

The Scandinavian design of the 1960s exemplified a move from technological to craftsmanship. Designers such as Alvar Aalto (1898-1976) and Tapio Wirkkala (1915-1985), surrounded by the natural and pristine Nordic environment, found in nature a symbol of freedom and a supplier of beautiful and malleable materials. Their utilitarian pieces reflect the aesthetic organics of nature. These qualities are still evident in the Scandinavian designs of today. These and many other examples represent a culture that finds inspiration in nature and in the wisdom of the local environment.

Consumerism and over-production continued to cause destruction and disconnection with nature during the last half of the 20th century. Countries and nations were divided by war, and scientific and technological developments led to a higher demand and increase in oil, mining extractions and food production. The environmental impact from such activities raised concerns for environmental ethics. Although design schools were well established, the subject of environmental ethics was not on their agenda. Designers such as Buckminster Fuller (1895-1983), Lewis Mumford (1895-1990), Ian MacHarg (1920-2001), Victor Papanek (1923-1998) and Sim van der Ryn (1935-), to name a few, were conscious of the problems and understood that the solution lay in nature's design.

Another important field that influenced designers, especially architects, is *biomorphism*. It refers to finding the similarity of structural form in living organisms in order to generate aesthetic and functional results. Art historian Alfred H. Barr used the word in 1936 to describe non-representational art using organic forms (Sanchez Ruano, 2010, p. 66). Biotechnology or biology-based technology, is another field of study that is analogous to biomimicry. It also relates to ideas of 'bio-utilization', where living organisms can be used or manipulated to respond to human needs in factory-like conditions. Biotechnology has been raising ethical concerns; nevertheless, scientists argues that biotechnology has been practised since humans started using yeast to bake bread (Toffler, 1971, p. 197). Currently, biotechnology is mainly applied in drug production, genetic modification or biomaterial design. Biodegradable plastic produced by bacteria is an example of biotechnology.

Alongside the new ideals of *synthetic biology*, the idea of sophisticated artefacts evolved, made possible through observing micro and macro worlds. Molecular biology, robotics and the Internet of things began to cross new boundaries. Scientists and designers became aware of the intelligence and docility of bacteria, animals and plants and their functions and interactions with humans. This led to experiments such as growing walls and tissues, pollination of crops, geo-engineering artificial islands, and tracking population levels of organisms. There is a growing awareness of the unimaginable consequences of unethical genetic modification of materials and organisms. If dolphins and whales can help us to fish, birds to communicate through distance, bees to inform our agricultural purposes or viruses to control population, then we can design with those true participative bio-technologies. As soon as we understand this biomimetic language, we will be able to fulfil ethical requirements. Here, bio-utilization of organisms will transcend to be active to participants in the process of life.

The history of biomimicry demonstrates a division between arts and sciences, and also the natural history of design. Today, biomimicry proliferates in several branches under different titles, but they generally represent a common ground: biomimetics, bionics, bio-design, bio-inspiration, biologically inspired engineering, biomimesis, and biomorphism, to name a few. Hoeller and other biomimics (Eggermont et al., 2013b, pp. 136–146) recognize that biologically inspired design often adopts a different stance. He also observed that along with the study of sustainability ideas, biomimicry has been motivating the conformation of interdisciplinary networks around the world. Hoeller and others maintain that the 'common ground' among different disciplines is important to identify actions that will help us to build unity of methods and outcomes of learning.

Finally, biomimicry – and Biomimetic design – as a contemporary term, is beginning to permeate our culture. Janine Benyus expresses this need to establish a formal movement. She notes: 'Biomimicry has the earmarks of a successful meme, that is, an idea that will spread like an adaptive gene throughout our culture' (Benyus, 2002, p. 4). Centres for the study of biomimetics and Biologically Inspired Design Labs have sprung up in recent years in universities all over the world (e.g. CBID, WYSS institute).[33] As a result, journals such as *Bioinspiration and Biomimetics* (2016) and *Zygote Quarterly* (2016)

[33] http://www.cbid.gatech.edu, http://wyss.harvard.edu

have been established. Organizations, such as the Biomimicry Institute[34], and the recent formation of national networks such as Biomimicry UK[35], aim to bring together research groups and establish educational platforms and new kinds of bio-inspired business.

Looking at the history of the discipline highlights its evolution from bio-technique to biomimicry, which happened as a consequence of the evolution of technology, education, and ultimately, the collaboration between arts and sciences. By tradition, or technical terms, the definitions of 'biomimetics' and 'bionics' are still used by several research groups and the population; nevertheless, these terms focus on prediction and control, requiring flexibility in their qualitative aspects. On the other hand, the use of the term biomimicry, or biomimesis, is widely used by biologists who follow the initiatives of designers and architects. This interdisciplinary approach is reinforced by ecological and sustainability principles, creating a solid conformation of the meaning of this term. Within this research, the term biomimicry is considered to be the most comprehensive title for design academia.

c. Contemporary examples of biomimetic design

Nature-inspired design is becoming more prevailent. It is incorporated in logos, jewellery, clothes, buildings and even in less tangible designs, represented in services, sensors and software. The *Dimaxion* car designed by Buckminster Fuller and inspired by the raindrop, the high-speed *Shinkansen train* designed by Hideo Shima (1901-1998) inspired by the kingfisher beak, turbines and aircraft inspired by sharks and stingrays, and architectural designs inspired by local flora and fauna, are among thousands of contemporary examples of applying the wisdom of nature to design.

Contemporary architecture has been a good ambassador of biomimetic design in recent years. One of the greatest examples is Santiago Calatrava's (1951-) work. Calatrava's motto '*Natura mater et magistra*', 'nature is both, mother and teacher' (Tzonis and Rosselli, 2000, p. i), expresses his deep fascination for geometry and engineering found

[34] https://biomimicry.org/
[35] Co-founded the author of this thesis. See http://www.biomimicry-uk.org/

in nature. Bone-like structures, inspired by human and bird skeletons, are used in the construction of *Ciutat de las Arts y Las Ciencias* in Valencia, Spain. Along with Calatrava, Javier Senosiain (1948-) follows the organic architecture movement, where he integrates the biodynamics of nature represented in his thermal and biomorphic constructions (Senosiain, 2003). Another example of this bio-architecture is the advanced lightweight materials and tensegrity studies of Frei Otto's (1925-2015) domes for the Olympic Park in Munich. Such lightweight materials are present in the imitation of micro-biomes and membranes that provide horticultural solutions found in Nicholas Grimshaw's (1939-) Eden Project facilities. The work of evolutionary architect Eugene Tsui (1954-) using the plasticity of the form and material properties found in natural structures have been part of his utopian buildings-like-cities aimed at solving the potential destruction of the biosphere (Tsui, 1999). More recenly, pneumatic structures and reactive facades, and the application of 'living materials', point to an era where architecture will adapt to climate change, as proposed by Rachel Armstrong (2012). Such futuristic concepts have also been displayed in international competitions such as *eVolo,* displaying buildings that are parasitic, grow like trees, or regenerate like the seasons (Aiello, 2010). The latest digital technologies, such as software applications and 3D printers, are providing designers with new opportunities. They are finding ways to print living tissues, create light-weight materials or self-driving vehicles. Nevertheless, many of these sophisticated technologies must recognise the potential for disastrous consequences if not used consciously, and with respect to nature along with the natural co-evolution.

The examples mentioned above, and illustrated in Figure 21, are some of the most popular examples identified over the course of this research. Although some are not the result of biomimicry thinking, many are used to teach biomimicry. Some of these examples already have already been proven at solving problems of infrastructure, materials or transportation. Presenting such examples in detail are helpful in introducing the topic to students in the classroom. (See more examples of other design disciplines on Appendix C.1).

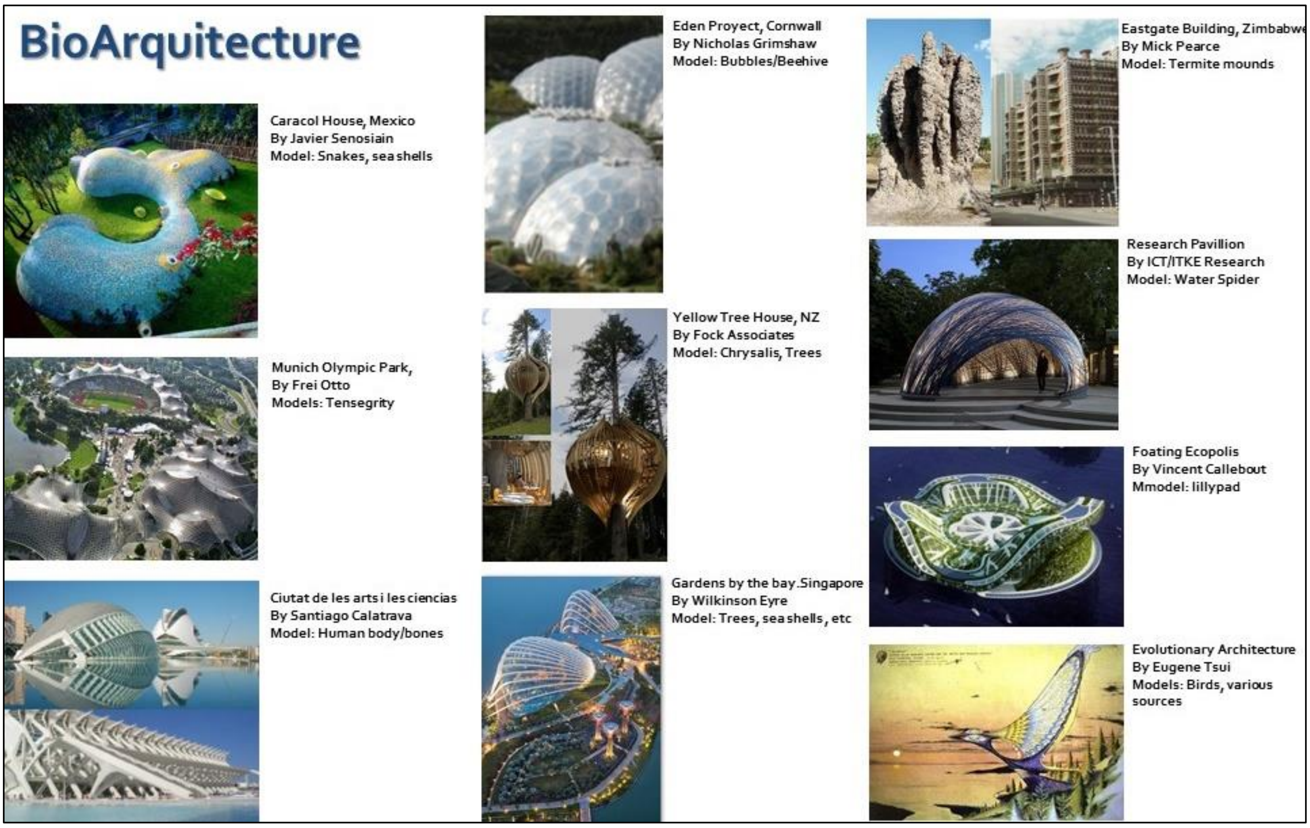

Figure 21. Biomimetic Architecture Examples

Being a biomimetic practitioner requires awareness and sensitivity to the fact that culture and nature work symbiotically. Being able to mimic the life of other organisms in order to solve human problems requires a trans-disciplinary education and holistic understanding of nature's ways. Most biomimetic minds have been developing such sensitivity by integrating nature's teachings into their practice. Contemporary Biomimetic practitioners who have been leaders in influencing the biomimicry field of research include Julian Vincent, Janine Benyus, Michael Pawlyn, Neri Oxman, Vincent Callebaut, Luc Schuiten, Norbert Hoeller, Tom McKeag, Dayna Baumeister, Daniel Wahl, Werner Natchigall, Achim Menges, Rachel Armstrong and Ross Lovegrove, among others.

Becoming aware of our limits in bio-mimicking requires sensitivity to the sources and background of the original design. A revision of our bio-inspired history, and a critical inspection of the actual trends in biomimetic design, is needed for acquiring the training. As pointed out in previous sections, biomimicry takes us through the process of relearning and rediscovering the design in nature, as is demonstrated in the following activity.

Activity. 1 Bio-inspired stories

Step 1. Bio-inspired history

Activity description: A graphic presentation, from ancient to contemporary examples of biomimicry, is fundamental to understanding how human ingenuity has been inspired by the natural world.

You can present it as a single session or over several sessions:

a. History of Bio-inspired designs: A time line of examples from ancient civilizations to industrial revolution. Include a graphical presentation of examples. E.g. Greeks writing about nature, Chinese silk, etc.

b. Biomimetic minds: Stories of discovery and collaboration between scientist and artists in the past to demonstrate the potential ways of biomimicry as a bio-technique. E.g. Leonardo Da Vinci, Ernst Haeckel and Rene Binet correlation.

c. Contemporary Biomimicry: A display of contemporary examples of biomimicry, from the design traditions of the Bauhaus to trending examples, e.g. Eden Project, Velcro, Sinkanshen train. (See Appendix C.1 and Appendix C.2 for audio-visual resources). Also explain the different definitions and synonyms of the term Biomimicry.

Narrative Instructions/Homework: Take notes during the presentation and find more information about your favourite example as homework. You might find another example in your search.

See the Research Explorations (4.1.c) on this activity.

d. Beyond metaphor and analogy: The social meaning of Biomimicry

As we develop a naturalistic way of being through design, we need to become more ecoliterate and conscious of not only natural aesthetics, but also metaphors and analogies that we generate for society. Metaphor is a 'transference of meaning from one source to a dissimilar target' (Borden and Collins, 2014, p. 270). On the other hand, analogy is a 'mapping of similarity or relationships between two or more phenomena' (*Encyclopedia of creativity.*, 2011, pp. 71–77). Metaphor differs from analogy in the mapping from a source to a target domain; metaphor is directional and analogy is bidirectional (*Encyclopedia of creativity.*, 2011, p. 209).

Analogy is used in biomimicry when the creative individual analyzes a problem from design to biology and vice versa. This is a very useful process forsolving problems and proposing diverse concepts. Encouraging the use and decoding of metaphors confirms the social meaning of biomimicry and the matching of the behaviors of human nature. This refinement is a mapping of morals and ethics of projecting biomimetic objects, services or infrastructure and changes social behavior as it affects physicality and worldview.

Steadman (2008, pp 4-10) compares the human production of artefacts and buildings with the evolution of organisms. He writes how this 'organic analogy' attracts special interest to designers in the way that connects with science. His idea of organic analogy is not only relevant to design theory, but also contributes to the formation of contemporary biomimicry thinking. For him, analogy has two distinct kinds of interpretation, 'visual appearance' or composition, and 'functional'. The interrelation of organic analogy with the history of biomimicry can be found in Henry Balfour's three stages of evolution of decoration:

1. 'Adaptive: Man simply accepted and adapted effects which were accidentally suggested to him'.

2. ‘Imitated: the natural effect is imitated artificially, in places other than where it occurs naturally’.

3. ‘Successive copying: The natural design has been once copied. That copy can be copied again, and so the motif takes on a *life of its own*. As it goes on the design varies for a number of possible reasons, either due to technical inadequacy or the exigencies of the material or the way the tool is used and so on defined as an *unconscious variation*.’ (cited in Steadman, 2008, p. 100)

Steadman also explains rigorously how a Darwinian analogy in the evolution in decoration (or of functional objects), is to assume that all changes in their forms were introduced entirely accidentally and without any forethought or deliberate intention (ibid, p. 105). Taking this into consideration, we can identify that biological analogies are certainly hazardous but are also innovative. As educators, we must guide, tell stories and facilitate examples of what can be considered ‘good’ design analogy, what constitutes the aesthetic pleasure and its dimensions with planetary boundaries. Biomimicry can be interpreted as an organic analogy as it deeply questions the creation of man-made objects and infrastructures as life systems or life-enhancing systems.

Contemplation, intuition and searching for harmony with nature leads us to use our senses to be open to recognise analogies in the built environment. Colors, forms or textures can attract at first sight and conquer our senses with pleasure. The archetypal patterns of the natural world underpin the creative process of human invention and how they relate to human consciousness and even teach us to contribute in return (Roszak et al., 1995, pp. 97–98). With these ideas, we can identify that a collective behavioral effort is required through biomimetic design education to ignite this re-establishment.

We need to find ways to condition designs as attractors of well-being and attractors of collective symbiosis with the natural world. Through recognizing the metaphorical and analogous aspects of biomimicry, we can make design a delightful everyday process of life, becoming habitual in our culture. Biomimicry aims to tackle wicked problems in design, approaching it as an attractor of beauty, efficiency, sustainability and ethical behavior. This biomimetic attractor recognition may lead to continuing inspiration from, and mutual understanding with, nature.

Biomimicry, in the formation of our humanism, is almost pure *metaphor.*[36] As metaphors are embedded in our everyday life, from speaking to writing and thinking, they are of course found in every design. As metaphor permeates our lives, there is place where art and science have a conversation enhancing our purposeful creative spirit. This means that through biomimicry, we are capable of bringing the language of nature into conscious action as we are surrounded by it. We design objects that resemble animals or plants, for example a tree-like building, or cars that resemble fish. The epistemology of biomimicry is based on the 'know how' of designing meaningful metaphorical connections with all living things. Like Bateson and Goethe, we need to expose the internal language of our 'biological epistemology' (Borden and Collins, 2014, pp. 174–175) by finding the patterns that connect us with other living beings, a sort of meta-relationship.

Using Biomimicry as a tool for design is to understand how to study a forest when building a city, to study the light flight of birds to design more efficient transport, to emulate the structural material of seeds/fruits to generate biodegradable packaging, to understand fractal arrangement of rivers or veins to design irrigation systems, and many other thousands of innovations that are among tangible metaphors that make nature visible.

There is no better metaphorical code than the observable, verifiable, measurable standards of the living nature in which we are immersed. Becoming aware of these metaphorical aspects through biomimicry makes us conscious of our evolution along with other species, whilst developing our technologies. Architect Paolo Portoghesi (cited on Steadman, 2008, p. 241), for example, uses the metaphor of windows as eyes, the dome echoing the sky, towers as stalks or inflorescences, columns as trees, vaults as ribs covered by flesh, or forest canopies; even the everyday language of architecture depends on anatomical metaphor ('skin' and 'skeleton', the 'head', the 'foot' of a column, the 'wings' of buildings).

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[36] Metaphor can be defined as a live cognition process; it has several possible roles in our creative thinking, from directly shaping our thought (drawing connections between abstract ideas and concrete experience) serving expressive, affective or communicative purposes. It also plays an active role in science to communicate scientific ideas. It also helps in pedagogy to engage with creative dimensions of diverse topics (*Encyclopedia of creativity*, 2011, pp. 109–119).

Biological terms are used in different aspects of our contemporary culture. A recent study challenged two groups of participants by asking them to find solutions for fighting crimes. One group was given the analogy of crime as a monster, the second was given the analogy of crime as a virus. Results showed that the 'crime as monster' group came up with solutions such as incarceration and punishment (as appropriate for a monster) while the 'crime as virus' group found more preventative, bio-inspired solutions (Biomimicry: The Power of the Metaphor, n.d.). This example shows that replacing one word (or adding an additional layer of information) can affect the way we use biological metaphors. Using metaphors to change the way we approach a challenge may be one of the strongest contributions of the biomimetic practitioner.

As designers, we must be able to identify analogies and metaphors in ethical ways. When biomimetic innovations are frequently and continuously applied and redesigned by people, they become cultural memes. If they are qualified as bio-inspired gizmos, they may have an undesired environmental impact or negative effects on human behavior. However, if they integrally follow life's patterns and analogical language, then design will succeed. Jay Harman (2013) foresees that biomimetically-inspired products will be found in the marketplace, from medicine to aerospace to manufacturing to transportation within the next ten to twenty years. He adds that we need to change our perception to conceive communities as ecosystems, including businesses, government bodies, and other social organizations. In this extent, analogies and metaphors should be applied and recognized intentionally. They can help to deepen the relationship between a design and its source of inspiration. Trying to solve problems by simply biologizing them, without looking deeper at the metaphor or analogy, may cause cultural anomalies and gizmos.

In search of ecological wisdom, having a framework or guidance for understanding the way nature works is crucial for designers to allow them to go beyond metaphors and analogies. The study of the 'Principles of Life' derived from biology becomes meaningful in the ideation process. Integrating these universal principles is the best way to keep track of the pattern language of nature. The following table adapted by Jonathon Porritt (2007, p. 167) interprets such principles in comparison with our human strategies:

Nature's Principles	Human responses
Nature runs on sunlight	Humankind runs on fossil fuels
Nature uses only the energy it needs	Humankind wastes massive amounts of energy
Nature fits form to function	Humankind forces Nature's form to fit its own function
Nature recycles everything	Humankind recycles next to nothing
Nature rewards cooperation	Humankind idolizes competition
Nature banks on diversity	Humankind opts for monoculture (destroys diversity)
Nature demands local expertise	Increasingly, the local is lost in a global economy
Nature curbs excesses from within	Humankind celebrates excess: greed is good
Nature taps the power of limits	There are no limits, says human kind

As shown above, the 'Principles of Life' can be used as an explorative and evaluative tool. When exploring function analogies or features in natural organisms against man-made technologies, inappropriate human responses are evident. The study of the principles of life, or in essence what the biology offers us, help us to analogically consider our symbiotic consciousness.

Recognizing those principles is a prime skill for the biomimetic practitioner. Questioning deeply the metaphor and analogy of nature in our human design is the way to unlock the relationship and semantics of designing. In such a way, biomimetic representations will dissolve what we think is artifice (human) and non-artifice (natural). The following exercise facilitates such study.

Activity 2. Recognizing the Principles of Life

Step 1. Principles of Life presentation

Activity description: Provide a brief presentation to introduce to the group the 'Principles of Life' studied in biology. The canvas used by the Biomimicry Institute is a good resource (See Appendix C.5) or any other source that includes the biological principles. Provide the students with a printed copy or digital image of those principles to be used in their project.

Step 2. Identifying Life's principles

Material: Natural Samples (rocks, feathers, leaves etc.) and Man-made samples (pens, mugs, cameras, bottles), printed labels.

Activity Description: In order to become familiar with the 'Principles of Life' and its patterns, you will ask the students to bring a natural sample and a man-made sample to the class. Prepare a set of labels which contains life's principles and human responses (See Appendix C.6). If you have a large group, you can split the group into teams, printing the same number of labels per team. Ask the teams to get together around a table.

Narrative Instructions: With your natural samples, man-made samples and a set of labels on the table, you will discuss in your group how Nature's principles are or are not related to the things you brought. Take one of the labels and then continue the discussion with others. After you finish, organize the labels into two groups: nature's responses and man-made responses.

Step 3. Biomorphize it/Anthropomorphize it

Activity Description: Using the same samples that the students brought to class, you will provide Template 1 (See Appendix C.7), on which they are going to use their drawing skills and follow the instructions. After the students finish, each will present to the group. This is an exercise that activates the notion of analogies and metaphors. It can be considered as an unstructured way of doing biomimetic design.

Narrative instructions: Using your samples you will follow the instructions of the template given. The aim is to biologize the man-made element and anthropomorphise the natural element. After you finish, write down the social and ecological values of the elements and present it to the group.

See the Research Explorations (4.1.d) on this activity.

e. Mimicking natural Forms, Functions, Processes and Systems: Briefing the design challenge

The most important task for the design educator is to teach future practitioners how to frame a problem or a need. The 'design brief', or challenge statement, must contain instructions and aims that lead to the development of an artefact or system, a tangible or intangible outcome. The creative community should address this essential task at the first stage of the design process. It is also presented at the first stages of the courses or modules in the design academy. Determining what needs to be solved through design helps with framing the questions, understanding the client's needs, finding the market niche or just creating something original (invention).

Design briefs can be applied to real world problems or to fictional problems (Blyth and Worthington, 2010). Usually, design pedagogy is oriented toward creating concepts or prototypes that will be mass produced by a company or a community. Framing an inquiry is what ignites the design process itself; here, the brief is key. Biomimicry is a way to solve problems by biologizing the inquiry. Based on the work of Wendell Berry, Krupp and Wann (1994) emphasize a fundamental way of approaching these inquiries by asking three basic questions: 'What is there? What will nature permit us to do here? And what will nature help us to do here?' Such basic questions should be asked at the beginning of the biomimicry research or even when planning a brief for a design course.

When given a brief, a designer can choose to tighten or push the boundaries in which the design problem is dealt with. By appointing aims and goals, the brief determines the output, which may be arrived at from different directions. However, the main role that the brief plays is sense-making (*Encyclopedia of creativity.*, 2011, p. 443) and providing a scaffolding (*Encyclopedia of creativity.*, 2011, p. 446) within which students develop their design process.

Design educators can guide students to first 'visualize' the context by using the biomimicry tools in order to find right enquiries. As a biomimicry design exercise, a design brief could pose the problem. In this regard, it is important to consider the immediate local contexts as well as the 'whole' (biosphere) context. The biomimetic thinking process can provide knowledge and methods to distinguish between the human centred and Earth-centred designs. Considering both contexts at the same time should be embedded in every design brief. With this idea, we can consider that, in any given design brief, a bio-inspiration step should be taken into account in order to design for the bigger context: our living planet. Offering guidance to use the biomimicry process will aid in identifying and selecting biological entities that will teach us how to design within the larger context.

Tom McKeag (Eggermont et al., 2013b, p. 100) demonstrates how important it is to frame the problem early on with those questions, to translate biological and technological applications without losing track. He created a bio-design cube (see Figure 22 below), a searching frame to organize a bio-design inquiry. The *what is it? Axis*, the three phenomena of Form, Process and System seem to cover the possibilities in this universe, and indeed, these diversions are often used in biological investigation. In the *key parameter Axis*, - Information, Energy and Structure – are the factors that might drive a particular phenomenon. In the *Where can it be applied? Axis*, the actual professional domains – Science, Design and Business – can be interpreted as the actual professional domains, based on the general categories of human endeavour – Discovery, Creation and Production.

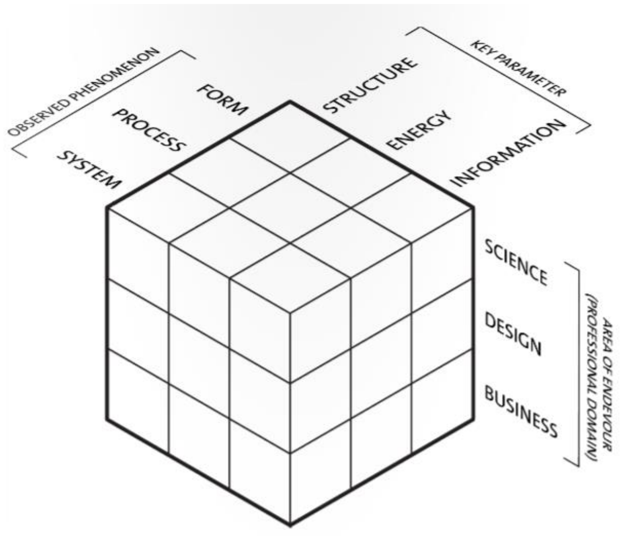

Figure 22. Bio-design Cube by Tom McKeag (2013)
The cube is divided into 3 dimensions of faces in order to locate a biomimetic design solution.

Biomimetic design is then subjected to four levels of design when approaching biomimesis: Form, Function, Process and Systems. Solutions lie at the level of form (structure) where a chosen pattern, such as a shape or texture, is used or where process (behavior over time) or a system (interconnection of components) is studied. At this level, there is more awareness and flexibility in generating the design solutions. It is sometimes difficult to identify function within forms or systems together.

Templates for identification of natural design principles, as is explained in the following activity, can help us to integrate them. This activity helps us to locate any design brief and to focus on the context of the given problem by using biomimicry as an eco-technique.

Activity 3. Focusing

Step 1. Identifying the need

Activity description: At this point you already have a challenge expressed in a design brief (See Appendix A.5). If the group is large, you might need to divide them into groups and give them a theme to focus on; this theme needs to be based on real problems in the society or community (i.e. housing, food, water).

Activity Instructions: Using Template 2 (See Appendix C.8) you will encourage the groups to identify real needs related to the theme given. When they complete their template 1 from the previous activity, they will be ready to explore further through other templates. They might need support to complete the template. Give an explanation to each group.

Step 2. Brainstorming audio-visual inspiration

Activity Description: Prepare some video-clips that feature the intelligence of animals, plants or ecosystems. Now the student will pay more attention and be open to learning from animals, plants and other living systems. A video that displays the themes given in the brief are recommended to help the student to identify smart strategies (See Appendix C.2 for more audio-visual examples).

See the Research Explorations (4.1.e) on this activity.

4.2 Designing as Nature: Action Stage (Convergent)

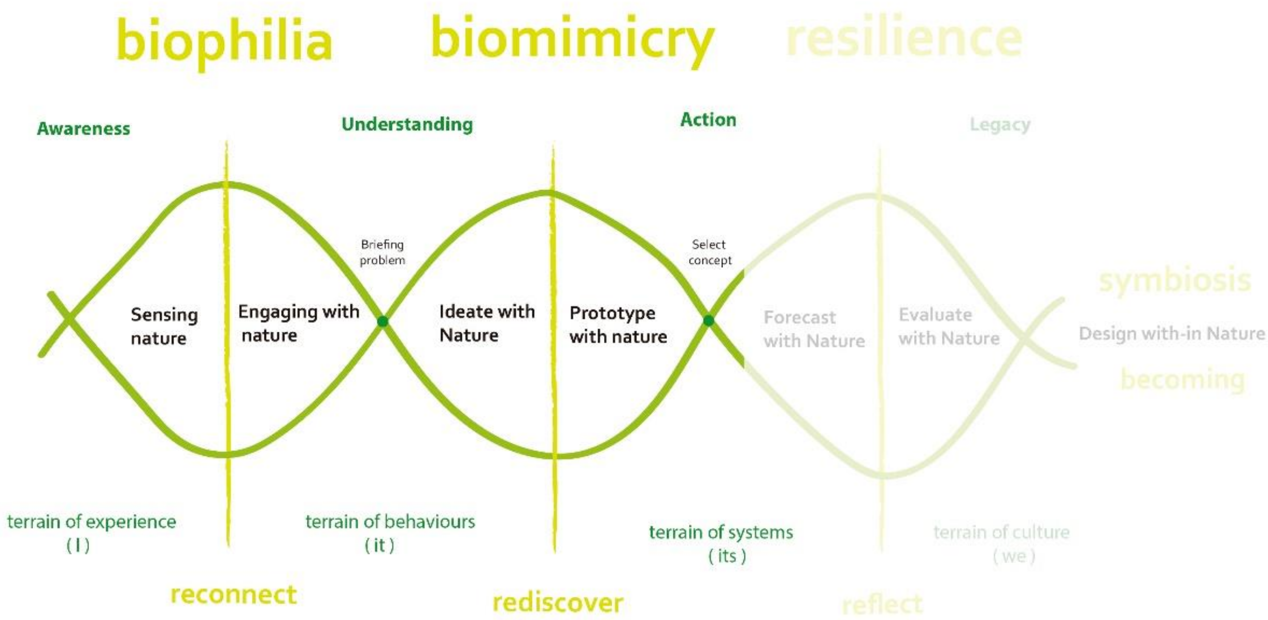

Figure 23. Biomimicry Action Stage

In the action stage the designer begins to detail their selected design proposals and analyze more biological information from the organism(s) selected. Here, an interdisciplinary collaboration is fundamental in order to develop a prototype. As we approach the terrain of systems (Its), the concept selected need to touch tangible and intangible ecological aspects.

i. Co-evolutionary aspects of biomimetic design

Biomimetic design reveals new ways of interpreting human challenges and its context through an evolutionary lens. Biological evolution, as the genetic transition or survival of the fittest, is not the only pattern we can refer to, but cultural evolution such as transmission of emotions, stories and knowledge of place also matter. Examples of such cultural evolution are found in ancient artefacts that reflected measures of the human body, and topographies inspired by the flora/fauna of the local place (we can refer to these as anthropomorphy, topomorphy or zoomorphy).

How long have we been replicating the natural world through objects or systems? Why do we want to design buildings like trees, or cars like fish? Looking at the history of evolution, we may be able to find answers for these questions. Artefacts, tools and architectural constructions are not just extensions of our bodies, but are the reflection of our relationship with a more-than-human world. We leave hereditary marks on the world in which we inhabit. We can refer to biomimicry as an *exosomatic*[37] heredity, which offers substitution or addition to the body. Clothes or architectural constructions can represent another layer of skin, cutlery an extension of arms and fingers, wheels improve the functions of legs, telephones increase the range of voice, hearing and sight, and books and computers amplify memory and mental power. The *endosomatic* heredity is embedded in receiving, interacting and replying to messages of Nature and its patterns.

New theories of genetics explore how information is passed on through the evolutionary process. For example, biochemistry has shown that some proteins do not change throughout their lifetime. However, constructed sociobiological elements can change some characters in proteins by creating restrictions on how they naturally occur. Medawar distinguishes the organic evolution from the human culture perspective (cited on Steadman 2008, p. 122). Seeing biomimicry as a tool to evolve our culture means that provides instructions for design in everyday life. Steadman expands on this idea by giving an example of the blacksmith, who can pass his skills on to his sons, and the knowledge of the blacksmith's craft can be inherited, as a way that our culture can change behavior.

It is argued that cultural evolution, and specifically technological evolution, is seen as a continuing phase of biological evolution (Steadman, 2008, pp. 120–122). In this *Darwinian* formulation, analogies are not explained thoroughly. On the other hand, Steadman refers to the notion of *Lamarkian* inheritance, which expresses the 'way of life' of an organism. One such notion is that the habits of the organism determine its form, rather than the other way round. The evolution of design can reverberate on the notion of biomimicry as practice, which may become a natural habit for the designer.

[37] Biologist demographer Alfred Lokta (in Steadman, 2008, p. 119) describes Endosomatic, or within the body, as the one we share with other creatures, while Exosomatic, or outside the body, is unique to our culture, which includes material artefacts.

Steadman (ibid, p. 126) uses Buttler's arguments to compare Darwinian 'organic evolution' with Lamarckian 'cultural evolution.' Buttler was an advocate of teleology and this manifested in his explanation of the evolutionary process, directed by arising needs and the experience of creatures. This helps us to compare biological evolution and the analogy with the evolution of technology; for example, we can identify the inadequacy of treating organs as if they were machines. Steadman's reference to 'tools as limbs' confirms how cultural evolution gives humankind extra organs, interpreted as machines. He concludes that technological evolution differs from the biological by virtue of the participation of the mind as an 'active intervention in the process'. He maintains that the Lamarckian argument is quite right in terms of the cultural evolution case, but quite wrong in the biological one. For example, Herbert Spencer conceived the society as an organism, and the institutions of society as organs in which thoughts and actions are subject to our environment (ibid, pp. 147–150). The intentionality of the designer, as discussed in previous chapters, and Steadman's arguments, turns biomimicry into a form of human evolution.

This idea helps to question the impact of biomimetic thinking in society. Are we going to extend the power of humankind and evolve in a certain direction? Or are we going to extend the power of 'us as nature' to symbiotically co-evolve? Evolution and biomimicry in design might be capable of establishing methods of working for sustaining life; whether it involves artefacts, infrastructure, systems or strategies to change or preserve cultural behavior, sets a new pace in innovation. From the Darwinian point of view, it is the environment that determines the change in the organism by imposing a range of variations. On the other hand, Lamarckism maintains that we are able to exercise direct effect in the environment through design. Teaching and learning to design along with nature in an appropriate fashion must be reflected in our culture.

Alexander (1964) also discussed the intentionality and evolution in the context of biological evolution. In his book titled *Notes on the synthesis of Form*, he framed a 'self-conscious' design method that represented an evolutionary design process in primitive or vernacular cultures. He introduces a broad distinction between two kinds of design processes, one which he calls 'unself-conscious', the other 'self-conscious'.[38] In the unself-conscious culture, argues Alexander, the same form is repeated over and over again, and all that the individual craftsman must learn is how to copy the given prototypes; but in the self-conscious culture there are always new problems arising, for which traditional given solutions are inappropriate or inadequate; therefore it is necessary to bring to bear some degree of theoretical understanding, in order to be able to devise new forms to meet the new needs.

An unself-conscious culture will be taught through imitation or correction in everyday life, and the self-conscious one in the academy and its rules (Alexander, 1978). In this way, Biomimicry shifts from the self-conscious to unself-conscious.If, in the unself-conscious process, the production of artefacts is extremely ingenious and embodies local knowledge and material, upon closer inspection of the nature of 'adaptation' (ibid), the result is achieved. The intermittent series of corrections makes unself-consciousness more valuable, that contrasts with our current accelerated technological evolution. Such adaptation means an understanding of the human purpose and following the rhythms of nature in its form and context.

For Alexander, the design activity is by nature imaginative and intuitive, and we can easily trust it if the designer's intuition is reliable. In the unself-conscious process, there is no possibility of misconstruing the situation: nobody makes a picture of the context, so the picture cannot be wrong. But the self-conscious designer works entirely from the picture in his mind, and this picture is almost always wrong (cited on Steadman, 2008, p. 175). Based on Alexander's point, we can suggest that biomimetic design needs to display coherent interconnectedness that corrects the fuzzy, intuitive and mistaken images of our anthropocentric mind, to bring the symbiotic and reciprocal participation in relation with nature's patterns. It is not to preconceive biomimetic forms, but to allow the pattern to emerge as informed by the natural context.

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[38] According to Steadman (2008, p. 164), the unself-conscious process is that which goes on in primitive societies, or in the traditional handicraft or architectural vernacular contexts; while the self-conscious process is that which is typical of present day, educated, specialized professional designers and architects. Steadman goes on to explain the unself-conscious and self-conscious Processes through the example of craftsmanship, where a technique that is mastered through time as materials and tools are felt, not just taught theoretically.

Applying biomimetic design to an established artefact is to 'evolve' an artefact. This means to revisit the precedents of those artefacts and make a sequential understanding of the source of inspiration. The history and tradition are the subject of 'biological fallacy' (ibid, p. 201). If we design consciously, with an established method of biomimicry, any given solution might have the potential of continuity with its historical-functional cycle. Digital technology is perhaps a tool that is helping us understand natural language at all levels – from micro to macro, from Archaean to Anthropogenic. The cumulative knowledge reflected in the natural history of artefacts, tools and now in digital archives, can help us to make sense in an almost archaeological way. Reinterpreting the meaning of bio-inspired design is to demonstrate the paths that took us to the present and observe how a design evolved. Finding the biological trace is to also generate biomimetic design.

We can conclude that a symbiotic design practice including biomimicry is more inclined toward a kind of Lamarckian 'instructive' process, as it might pass information from one generation to the next. The pattern language of nature, which is an accumulation of experiences and natural history, was perhaps intuitively identifiable by our ancestors. However, this language has been gradually disappearing. Design education, biology, and anthropology together have the opportunity to reframe their methods in order to retrieve evolutionary processes through biomimetic thinking. If we are going to instruct methods of learning from nature, perhaps we also need to be open to receive instructions other than those within the evolutionary format; a pattern language that relies on intuitions and instructions, that bring the self-conscious and unself-conscious to work together purposely.

ii. Memes and Biomimicry

This section discusses the re-creation of the language of life through biomimicry, meaning that we are able to create conditions more conducive to life. If we are willing to create a world of relationships informed by the patterns of other life forms, as a way of creating a more participative reciprocal design, biomimetic design has a key role in achieving that end.

To understand the information that the world gives us, we need to follow the logic of life. Powell (2014) suggests that such *bio-logic* is where our natural intelligence lies. Through evolution, life has learned a plethora of ingenious sense-making techniques (protein sequencing, morphogenesis, cellular orchestration, self-repair, replication, symbiosis etc.). The more environmental information you can access, store and organize, the more ingenious you can be in your behavior in that environment. In such a way, the conscious imitation of the patterns of life is then perhaps a survival strategy for humankind, or a step to involve or evolve our consciousness, as we still do not really know the consequences of mimicking tissues or androids. If our human world looks and functions in tune with the natural world, perhaps there is a greater chance for us to flourish.

If biomimicry is a design tool to reflect human action in re-establishing our place in nature, an innovative life-force, it might be also recognized as a practical tool for projecting symbiotic elements or 'memes' that trigger human action. The great source of ideas that Nature offers us can be valued and transformed, in terms of design ideas, as memes. The idea of memes is driven from the Neo-Darwinian theory explaining the replication of non-biological entities and their transmission in human societies (Dawkins, 1978). Dawkins identifies memes in the context of cultural evolution as a new type of non-biological replicator. These are the cultural analogue of genes, a unit of information that is passed from one person to another by imitation. They reproduce by transmitting from one brain to another through speech, a demonstration of techniques or written language. They vary as ideas, melodies or phrases, stored differently in the brain from one person to another. Csikszentmihalyi (1994) defines memes as a unit of cultural information, attitude or a way of thinking that is replicated through cultural tradition and imitation.

Memes of biomimicry have been shaping, reshaping and transmitting through different forms of green infrastructure, smart materials, ornamentations and even in our metaphorical language. They have been encoded in fashion styles or engineered products. These memes may also be found in vernacular ways of living and designs. Memes are transmitted, but we certainly do not know distorted they may become (Steadman, 2008, pp. 245–248). The copying and imitation process of biomimicry might be an inheritance of ideas through design and science. The semiotics that the bio-inspired design releases can perhaps become 'self-correcting' as a meme, something that permeate in the patterns of life.

Turner (2007) convincingly argues that this kind of natural selection needs to be embedded in our environmental psychology, and of course motivate the intentionality to design with ecosystems, an action that would take us beyond Darwinism. Training the biomimetic practitioner, then, requires that the difference between cognition and intentionality must be resolved by framing a mentality about what we experience, think and imagine. Here, our biomimetic meme must be expressed as a symbiotic response.

Just like a symbiotic cell that adapts and fuses to correct human impact, the pursuit of such a culture requires teaching biomimicry through interdisciplinary. Design history and evolutionary approaches are among the disciplines the biomimetic practitioner must pursue.

iii. Biomimicry as an interdisciplinary creative process

Biomimicry is a trans-disciplinary approach to problem-solving which has emerged through the integration of design with other disciplines, such as biology and engineering. It opens up possibilities of seeing the way nature works, teaches and informs arts and sciences. It encourages deeper studies in order to arrive at technologies and strategies that may be achieved through interdisciplinary dialogues.

In this position, the biomimetic practitioner needs to consult the relevant disciplines to find the most accurate answers to the design question before proceeding to the implementation stage. For example, scientific methods used in biology and other sciences can complement the design process. The creative process of biomimicry relies on finding fundamental questions regarding the challenge, making inquiries through prototyping and bringing together interdisciplinary teams.

A good biomimetic practitioner is able to analyze their bio-inspired ideas against human and nature's needs, develop accurate research by integrating 'biological information' and evaluate engineering and ethical elements in further stages. By using biomimicry methods, the practitioner develops hypothetical principles and mature design ideas. This kind of interdisciplinary process requires a direct observation of organisms and involves scientific information and analysis.

By becoming biomimics, designers and biologists aim to create accurate results through their interactions. Biomimicry provides a platform to understand common concepts between sciences and arts. In the same way that the orthodox designer becomes specialized in knowing materials, form or ergonomics, the biomimetic practitioner acquires knowledge related to biophysics, zoology or morphology to be incorporated in their design. A biomimetic practitioner becomes, in a way, an open-minded 'naturalist'. By bringing together biology and design teachers, they are able to create a new educational paradigm. They can provide a radical understanding which acknowledges the patterns of life and puts them into action together, through design. This educational paradigm represents new interdisciplinary skills and innovative platforms for research.

The biomimetic design process has a close interaction with biology and its sub-disciplines. It applies appropriate methods for abstraction to achieve an output and scientific research. Using a design thinking process to analyze the principles of life is always an experimental process, which may lead to a successful or unsuccessful design outcome. The relevance of questioning the outcomes of the biomimetic design concept of a prototype helps us to reach a level of technological capability and pursue a natural suitability for our planet.

An effective communication between disciplines is essential for a successful biomimetic result (Pacheco Esparza, 2013). It is important to be aware of the risk of miscommunication which may occur in the process of translating concepts from one discipline to another. In biology in particular, the terminology may sometimes be difficult to understand. In response to this problem, Helms et al (2009) suggest a kind of shared language, codes and methods between the involved disciplines.

The way in which design is understood to move from being an applied art (objects, crafts, emotion) to becoming closer to the sciences (materials, interactions, reactions, measurement), has placed the discipline in the position of a flexible and adaptable practice for solving physical challenges or reframing intangible processes. The division between design disciplines, from design engineering, industrial design, interaction design, service design and now digital interaction design, places the designer on a quest to either become a specialist by using certain tools, or, in some cases, become an interdisciplinary expert. The need to acquire tools or methods from other disciplines is a key challenge of our time. The way in which universities are teaching design depends either on traditions or constant trans-disciplinary actualization. Ultimately, the contemporary designer must be guided to adapt methods and apply them to bring forth well-being for the world and to understand how the world works, an aspect that biomimicry as an eco-technique facilitates.

As a flexible and integrative discipline, design can play an important role in creating interaction and translating or transferring concepts between disciplines. Design can function as an intermediary in the exchange of ideas. As discussed before, designers have the ability to interpret problems and analyze needs in order to implement intentionality. The responsibility for the designer in the biomimetic work is to link the biological and the technological, translating biological information and generating practical applications (Pacheco Esparza, 2013, p. 32).

Working with biologists provides designers with accurate information about organisms (environment, behavior etc.) and ways to delve into detail (taxonomies, anatomy etc.). By familiarizing themselves with the biological terminology, designers should be able to map their bio-inspired idea and find ways to accurately implement it with the biological research. Here, the biomimetic practitioner should be able to make sense of basic concepts of other disciplines by referring to related sources of information or consulting experts in the field. This may lead to direct dialogues about basic elements of their disciplines where agreement among the parties is required to facilitate the mutual process. This trans-disciplinary dialogue is beneficial as it increases possibilities not only for the design practice, but for other disciplines. Biomimetic practitioners are in this way the channel to facilitating suitable multidisciplinary solutions.

iv. How biology works, how design interprets

Knowing the terminology used in biology is fundamental for the practice of Biomimicry. Scientific names (formal classification) versus common names of organisms is one of the first causes of miscommunication that must be considered (e.g. *pissitacus allexandri* as the scientific name, versus *Parrot* as the common name). The *binomial nomenclature* is the internationally agreed code that facilitates the names of species (Cadogan, 2000). Another important aspect to consider is the *taxonomy*, which is the classification of species in related groups to facilitate the identification. The six *Life kingdoms* (Animalia, Plantae, Fungi, Protista, Archaea and Bacteria), the root family of organisms, are also important to identify. Rules of biology help to find information to understand biological entities and have a particular focus on points in the vast biological universe in which to explore. The biomimetic practitioner should then be able to use biological terminology in developing meaningful ideas, objects, services or messages based on the data of organisms.

In the terrain of biological sciences, the terminology, focus, methods, rules, theories and experiments are rigid. On the contrary, the design terrain offers flexibility in communicating and receiving information from different sources (systems, individuals, levels, disciplines). When the two different terrains, such as biology and design, combine, innovation arises and common ground emerges. In this context, biomimicry may initiate the process of creating a shared terminology that includes a language of life itself. The integration of biology and design is a response to the inquiry about the concept of co-evolution which, if carried out, may lead to the development of a bio-culture, as the diversification of the language and design for life is learning to behave along with nature. Ultimately, the roots of this naturalistic discipline come from the long tradition of biology and physics, and now crosses the boundaries of holistic studies.

Biologists have been accumulating knowledge of nature for centuries. Theories of biology tell the stories of relationships between the life kingdoms. Today, it seems that biomimicry may be a practical way to transfer those stories to non-biologists through ecoliteracy. Emotions, ethics and complexity are abstract experiential ways to learn from nature, as discussed in the previous chapter. Biology, as practiced in the controlled environment of laboratories and schools, is only one way of studying life. But for the biomimetic practitioner, biology becomes an experiential tool that unravels patterns of nature around us.

Biologists, physicists, engineers and economists are looking for ways to translate their knowledge into forms that are beyond isolated inventions and theories. Therefore, it is essential to exchange knowledge and experience by bringing the designer to the laboratory and the biologist to the design studio, but more importantly bringing both groups to the real natural locations; outside in the field, the terminologies, ideas and peculiarities of the way of life of non-human beings become evident.

Once biomimetic design reaches the general public and other sciences, it's true potential will be released. Every act that we bring to the world will be focus on the intersection of design beyond art and biology, beyond science. However, if Biomimicry is treated as a scientific or an engineered process, it is destined to fail. Although the rigidity of scientific experiments is an important factor in generating valid and quantitative results, the use of intuition and empathetic techniques is equally important in studying organisms as sentient intelligent beings. This is where the collaboration between science and design can develop a new and more holistic understanding, as well as solutions.

It is at this Biomimicry Action Stage (See Figure 23 p.186) that the biomimetic practitioner emerges. He/she enables their creativity to mature through learning from nature, in an interdisciplinary way. The following sections demonstrate converging points where engagement and prototyping with natural patterns affirm a biomimetic practice.

4.2.1 Prototyping with Nature: Biomimicry as conscious design intention

The success of a biomimetic design depends on the amount of information that is collected and analyzed about the organism (biological data), and also on the technological background of the artefact or system (needs, context, history) that will be redesigned or newly released for our world. The design brief, and the deep questioning of any invention, will determine the biomimetic focus as a system, function, form or process. Once the experimental creative process begins, the need for biological research arises.

Biomimicry is a tool that can help us find options and can sometimes force the researcher to find answers (Pacheco Esparza, 2013, p. 42). Using a natural pattern does not guarantee that the biomimetic artefact or system will work; for this reason, a prototype (digital or physical mock-up) is required. As the prototype is developed, it will be acquiring features that can be evaluated and modified, if necessary.

'How does nature do...?' is a key question to ask in the process of implementing biomimetic thinking in design. It suggests new ways of inquiry in designing infrastructure, messages or artefacts using keywords related to natural forms, functions, processes and systems found in nature. Online tools and databases facilitate finding information about the organism from which the emulation will be done. The difficulty occurs when the learner must structure this information, or validates its accuracy.

4.2.1.1 Biomimetic practitioner's tools

a. The methods of biomimicry

In these section, a number of biomimicry methods and exercises, regarded as 'Biomimetic practitioner's tools', are described. These descriptions provide examples of the application of the biological terminology used by the biomimetic practitioner. These tools were gathered and studied as part of this research. These are sources of inspiration in developing new educational tools, and these are justa small sample... All these methods have been developed and used by researchers from diverse backgrounds, and are supported by interdisciplinary pedagogical techniques and computational tools:

Life's Principles and Design Spirals. The Biomimicry Institute developed an educational tool called Life's principles (See Appendix C.5). These principles, framed by biology and design traditions, are used by practitioners as a guide for following the pattern and the intelligence of organisms that are studied, and to unveil new possibilities in the development of design products (services/systems) or technologies. The institute also developed a design method called Biomimicry Design Spirals, or Biomimicry Thinking Lenses, developed through doing biological and design research (Baumeister, 2013)**.** The spirals are widely used by biomimicry specialists and educators as an effective method of problem solving. There is a two-way process in the biomimicry spirals/lenses method:

Biology-to-Design is used when the practitioner identifies in an organism, or system, any form, function or process that could be translated to design. This process enables the practitioner to develop design concepts through studying a biological organism that can be incorporated into new technology or organizational processes. This path is most appropriate when the process initiates from an inspirational biological insight (including a Life's Principle) that the practitioner intends to incorporate into a design.

Challenge-to-Biology is used when the design brief or design problem specifically asks for a solution that will be arrived at through mimicking organisms or ecosystems. In this way, artefacts, behaviors and related technological solutions are biologized and redesigned to include life's patterns. This way is particularly useful for a 'controlled' setting, such as a classroom, or for creating an iterative design process. The best outcomes occur when the practitioner navigates the path multiple times.

BioTRIZ. is a problem-solving tool originating from the analysis of the world of patents, which comprises a set of rules and techniques to practically solve any problem, technological or managerial. The TRIZ model of creative design is a normative method with a strong engineering tradition. TRIZ is the acronym of *Teorija Reshenija Izobretatel'skih Zadach* (translated from Russian as 'Theory of Inventive Problem Solving). The tool was developed by Olga Bogatyreva, Nikolay Bogatyrev and Julian Vincent at the University of Bath (Vincent et al., 2006).

BioDesign is a method of analysing biological data along with the traditional design processes. It looks for data in the biological taxonomy of the species, while incorporation analysis into a design concept. This method was developed by biologist Janitzio Egido at the National Autonomous University of Mexico (Egido Villarreal and Universidad, 2004).

Cross-domain analogies and keywords is a tool that offers analogical reasoning by mapping engineering functions to biologically relevant keywords, searching existing sources of biological information for appropriate context, and developing insightful analogies that map the biological context to strategies relevant to engineering design. Developed by Engineers at University of Toronto (Eggermont et al., 2012c, p. 136).

E2B Thesaurus is an engineering-to-biology tool which facilitates working beyond the professional boundaries. It allows engineers without advanced biological knowledge to leverage nature's ingenuity in the design process. This tool uses synonyms and modelling terminology, which is familiar to engineers. It was developed by Jaqueline Nagel at James Madison University (Eggermont et al., 2012d, p. 102).

Bio-Design Cube is a tool that provides a framework for designers to search and organise their bio-design inquiries. The "sides" of the cube help to find the area of endeavour (science, design or business), key parameters (structure, energy and information) and observed phenomenon (system, process and form). This tool was developed by Tom McKeag at the University of Berkeley (Eggermont et al., 2013b, p. 100) (See Figure 22 p. 184).

System Explorer is a tool for exploring downwards, upwards and sideways to determine system interconnections when a form or process is identified in an organism. It involves the collection of data by identifying the coupling and boundaries within sub-systems. The method helps in the connectivity, membership and resources identification. It was developed by Curt McNamara at Minneapolis College of Art and Design (Eggermont et al., 2014b, pp. 92–115).

Dane 2.0 or Design by Analogy to Nature Engine is a tool that facilitates particular kinds of analogical design activity, as well as researching the cognitive underpinnings of analogical design. Developed by the Design Intelligence Lab at the Georgia Institute of Technology, this tool is one of the successful methods used in the SBF (Structure-behavior-function) (Eggermont et al., 2013a, p. 5), which focuses on communicating the components and behaviors of a nested system ("DANE: Design Analogy to Nature Engine," n.d.).

With the following exercise, the biomimetic practitioner is able to use these well-known methods and other templates to identify the sources of inspiration by undertaking appropriate biological research and treating the organism with empathy. This is a step that helps us to rediscover the patterns of life.

Activity 4. Rediscovering

Step 1: Ask Nature how?

Activity Description: It is by identifying the key question, *How does Nature solve this problem?* that the design process continues. Biologizing the problem, or dismantling it into technical words or questions, is the first step in commencing the biomimetic design process. After completing the previous template (Template 2 appendix C.8) to identify the design problem, the teacher will encourage the students to complete the first section of Template 3. Rediscover (See Appendix C.9) in order to list the species in which we can find answers or to place the design need identified to biologize it.

Step 2: Biological Empathy

Activity Description: The biological empathy is considered a fieldwork activity to begin the exploration or direct conversation with a living organism. The design of Template 4. Biological Empathy Map (See Appendix C.10) incorporates features of the Goethean method of observation that can be used on site or using samples or pictures of the organism selected.

Activity instructions: In a format of drawing and interviewing, Template 4 will help the practitioner in going deeper and straight to the biological features, to analyze further. The teacher guides the students or groups in finding the right answers by using biological databases and scientific publications.

Step 3. Collecting biological data

Activity Description: Once the student or group of students has focused on one organism, it is time to identify its forms, functions and interaction systems related to the brief and challenge given.

Activity Instructions: Using Template 5. Biological Research (See Appendix C.11), the student will be able include sketches, pictures, word definitions and related scientific data of the organism or parts of the organism chosen.

See the Research Explorations (4.2.a) on this activity.

b. Natural Prototyping: The value of designing as nature

Designed objects, services and messages should be rigorously assessed before being implemented into the public sphere. Using physical prototypes or digital modelling to observe immediate effects is crucial to making decisions as to which designs to take to the next stage of further development.

Prototyping is a generic problem-solving approach in navigating a challenge. Valentine (2013) regards prototyping as 'a key means with which an individual's imagination is tenaciously explored, tested, broken and rebuilt'. It is important not to merely rely on theoretical predictions during the design process, but to use prototypes in order to assess the performance of the product (object, service or system) and the emotional impact (perception) and value judgements (ethics) it stimulates in the users.

Natural prototyping is key to design intuitively and being open to emerging situations, whilst embracing the principles of life or any kind of biological laws that we are studying (see Appendix C.5 for example). Here, the biomimetic practitioner participates in the design process; they develop an accurate design concept, evaluate it and produce a reflective outcome according to the principles of life and the interconnectedness of all beings. The way in which the natural prototype is created will articulate a new cultural behavior as a natural meme.

The following exercise can be considered as part of the conventional design process which implies the conceptualization – from brainstorming to selection of the final idea – not the physical fabrication of an artefact or system. This is the final step in the stage of 'prototyping with nature'. The aim of a prototype is to provoke discussion and reflection within groups (of students and professionals) and invited experts (from biological sciences or engineering) to encouraging true interdisciplinary research and criticism.

Activity 5. Prototyping

Step 1: Natural Prototyping

Activity Description: Finally, it is time to translate Nature's language into the design concept. The students are allowed to use their own imagination but at the same time respond to the natural design of the organism.

Activity instructions: Using Template 6. Natural Prototyping (See Appendix C.12) and a sketchbook if needed, the students will commence the development of concepts.

Step 2: Final concept selection

Activity Description: It is time to choose a final concept. If teams were organized, it is suggested to do a group review in order to integrate the ideas of each member of the team and choose the final concept. Remind the students that the concepts will be reviewed toward the final stage of the workshop, module or course.

See the Research Explorations (4.2.b) on this activity.

4.3 Guided by Nature: Rediscover Phase

Over 3.8 billion years, plant and animal species have devised solutions with maximum performance and minimal use of resources. We have been studying and seeking to emulate Nature's genius in the production of materials, structures, processes, algorithms, mechanisms and systems in order to respond better to the changing conditions of the planet and, indeed, our local context. However, in many cases, our emulation of nature leads to the production of objects that are not harmonious with natural cycles of life, and increases the fragmentation and dissonance between the human-made and organic lifestyles. This continuing trend has resulted in severe outcomes and problems, and there is a strong probability that this will escalate to the level of endangering the existence of life on the planet.

Every species, including human, is important in maintaining the balance in the current ecosystemic interaction. Understanding and acting on this interactive basis allows us to thrive symbiotically along with other species. Design education should incorporate this way of understanding and action. Design teachers and researchers have recently started to look at nature not only as a source of harmonious aesthetic forms, but as a collection of sensible, intelligent and sustainable systems that are more efficient than traditional human compositions. Biomimicry, along with ecological design, is now diverting designers' creativity in order to appreciate the ecosystem as a source of joy and well-being for all the living. This research not only highlights the potential of this eco-technique, but also suggests ways for design education to establish a system of human creativity that goes hand-in-hand with natural creativity.

Regarding the benefits of biomimicry in our present society, the biomimetic practitioner is able to exaggerate such benefits by taking advantage of our current ecological crisis. Although some biomimetic projects are well-adapted, others are only associated with ambitious proposals that can cause unforeseen and unwanted effects; for example, the mass production of biomimetic devices with the wrong material cycles, or manipulative political or economic strategies.

As biomimics, we recognize that 'organisms have evolved to work smarter' (Benyus, 2002, p. 5), and that forms fit their function and economize by combining multiple functions (recycling,mutualistic processes, etc.) Through the centuries, and perhaps unconsciously, the emulation of nature has made us smarter, but now that we are conscious of such power, it is time to identify the ethics behind the aesthetics. From structures to textures, we cannot simply apply what is in nature to objects or constructions without ethical considerations. Eugene Tsui warns that 'one cannot simply take a chosen form and attempt to enlarge or reduce it without dangerous consequence' (Tsui, 1999, p. 21).

Pacheco-Esparza (2013, p. 38) argues that biomimicry as a 'specialty is a study of values'. Biomimicry is situated not only in the psyche of the individual practitioner but in a collective understanding, by society and interdisciplinary research groups. Biomimicry can illustratean ethical win-win aspect that can only be achieved along with other species. The great contribution of the idea of biomimicry lies not only in the inspirational facts or the generation of novel ideas, but in the identification of implicit cultural values.

Disciplines like design, that have a strong attachment to invention and innovation, are capable of generating habits or customs that take into account natural responses. It is important to raise awareness of the problems that bio-inspired design may potentially cause at the planetary level, and, therefore, this must be included in the formation of the biomimetic practitioner. Such an awareness encourages practitioners to ethically examine and evaluate their designs at the individual and collective levels, aiming to embed the value of nature into the 'common sense' of everyday life and into social and individual perception of nature.

One of the objectives of this research is to explore ways to awaken interest in biomimicry through design education. However, this research does not aim to do this by reframing design as a discipline, but rather by forming a critical understanding of the patterns of nature as a skill. An understanding of this human need and commitment is key to embedding symbiotic values into design proposals. Co-designing with other life forms motivates the acquisition of such values.

Therefore, the axiology of biomimicry encourage positive action that is not focus upon human ingenuity and its industrious way of life, but is determined to incorporate a bio-synergistic philosophy (Mathews, 2011). The ambivalence of nature-artifice, and its ethical values, may lead us to move our society toward the co-evolutionary aspect of biomimicry. This can be done without forcing bio-inspiration but by highlighting the value of helping nature and letting nature help us as a moral fact.

4.3.2 Foundations: The character of the Biomimetic practitioner

Nature is a repository of wisdom. If we continue to investigate her patterns by engaging our perception through the biomimetic thinking process, we will be surprised by the wealth of knowledge and inspiration that we receive. It takes us beyond the sustainability approach as it encourages us to re-imagine the world we inherit in nature's image. Eco-technique is characterized by physical, geographical and biological environments, in which different species live and influence each other. Biomimicry, as a tool, allows design practitioners to search for better alternatives, analogies and metaphors to transform societies, by reintegrating ancient instincts that within our genes and promoting a cultural meme.

Appreciating nature, and contextualizing its wisdom in the academic field of design, might generate an active approach of biological and scientific interdisciplinary information toward acting as one with-in nature, through artefacts, services or infrastructure. In essence, the process of learning with nature is to *properly participate in the world*. The learning never ends. We know that natural phenomena keep changing and surprising us, and we need to seek for ways to adapt to their rhythms and complex flows. Failing to design technological connections according to those rhythms and patterns revealed by biomimicry, may lead to an unsustainable society.

The biomimetic practitioner adopt an approach to humility toward learning from nature and must acknowledge the abundance of knowledge that can be learned from other species, in a myriad of ways. Their biomimetic imaginarium constantly expands and mutates. The great responsibility of the biomimetic practitioner is to ensure fit and ethical intentions in its design processes and products. Whether it is referred as bio-inspired design or biomimetics, it is the process through which human ingenuity and a sense of wonder seeks to rediscover natural patterns and relationships embedded in the life of others that can then be used to create design solutions. The only way to succeed throughout this process is to endlessly maintain the sense of awe and respect for non-human designs.

Differentiating this degree of openness and self-inspiration should be one of the biggest concerns for the biomimetic practitioner. Being in *homeostasis*[39] with nature is to respond to its stimuli, to grow, to reproduce, and to adapt together. We can develop the capability to design cities that change with the seasonal temperatures, to regenerate regions while respecting soil and species' ways of life, to develop biomaterials and robots attuned with natural patterns. We must,however, be aware of the potential of inadvertently promote wrong, or unnatural patterns.

Only when we look at the bigger picture, and see nature as a coherent and sensitive system, can the practitioner properly begin to mimic nature's intelligence. But if the biomimetic practitioner spends too much time analyzing details, they may miss the larger context. This is paramount for developing an understanding of the systemic self-organizing intelligence of nature.

For centuries, the biomimetic design evolved unconsciously, and even accidentally. However, it has now arrived at a critical point: it has recognition, it has led to great technological advances and it has encouraged the development of a multidisciplinary understanding of the nature of design.

Biomimetic design as eco-technique requires integration into new educational and behavioral schemes. Biomimicry offers not just inspiration, but critical questioning and analysis of design projects and their biological and ecological roots. Nevertheless, the notion of biomimicry is still mutating and forming.

Taking the biomimetic approach to design does not mean creating new nature-like designs, but rather enhancing, reframing and enlivening the designer's ingenuity and

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[39] Defined in dictionaries as: the property of a system in which a variable (for example, the concentration of a substance in solution, or its temperature) is actively regulated to remain very nearly constant.

skills for unleashing mutualism between human and non-human designs. Arriving at this point of mutualism and harmony depends on modern technological tools that can teach designers about the Earth's life and help them to manage and use what they inadvertently learn and unravel wisely. The ability to produce transparent meanings is one of the fundamental qualities of a biomimetic practitioner. It is an ultimate ecological virtue that designers should pursue.

Today, we are more conscious of ways that design can change behaviors. As we evolve, our technologies affect our natural adaptation or maladaptation. There is so much to explore through the practice of biomimicry, from highly sophisticated 3D printed digital technologies, to the simple vernacular ways of embedding biomaterials. Materials that already exist in nature need only to be harvested, and not synthetized. The aesthetic promoted by biomimetic practitioners can perpetuate the ancient patterns of life's meaning that have been studied in the biological sciences and decorative arts, and that are now present in the time of digitalization. A good mediation of craft and design may be more valued in the biomimetic imaginarium.

The urgent need to manage resources and redesign the economy compels biomimetic practitioners to look for ethical and effective solutions. Biomimicry as an eco-technique provides a naturalistic lens to frame those challenges. The ability to grasp the biological knowledge, and merge it with the ability to ideate through the design process, opens up systemic modes of understanding and ways of learning, which can elevate the level of consciousness. The challenge is to guide practitioners to encounter and question our human desires. Figure 24 shows the foundations that the biomimetic practitioner acquires.

This chapter reviewed a selection of literature and tools which may help students to rediscover the creativity of the living world. The intersection with biological sciences allows designers to expand their creativity. This second phase, called 'Rediscover' (see Figure 23 p.186), facilitates the acquisition of a naturalistic lens and the formation of interdisciplinary teams. It also helps to acknowledge how biomimetic design can contribute to a conscious and integral change in cultural behavior. In this phase, we moved from the 'it' to 'its' – as in integral theory –, referred as nature's way. Knowing a varied range of biomimicry methods and tools enables design students to step into the realm of biology and open their minds to receive wisdom and inspiration that can help them develop natural prototypes. The phase concluded with the selection of a concept that will be evaluated in the next reflective stage.

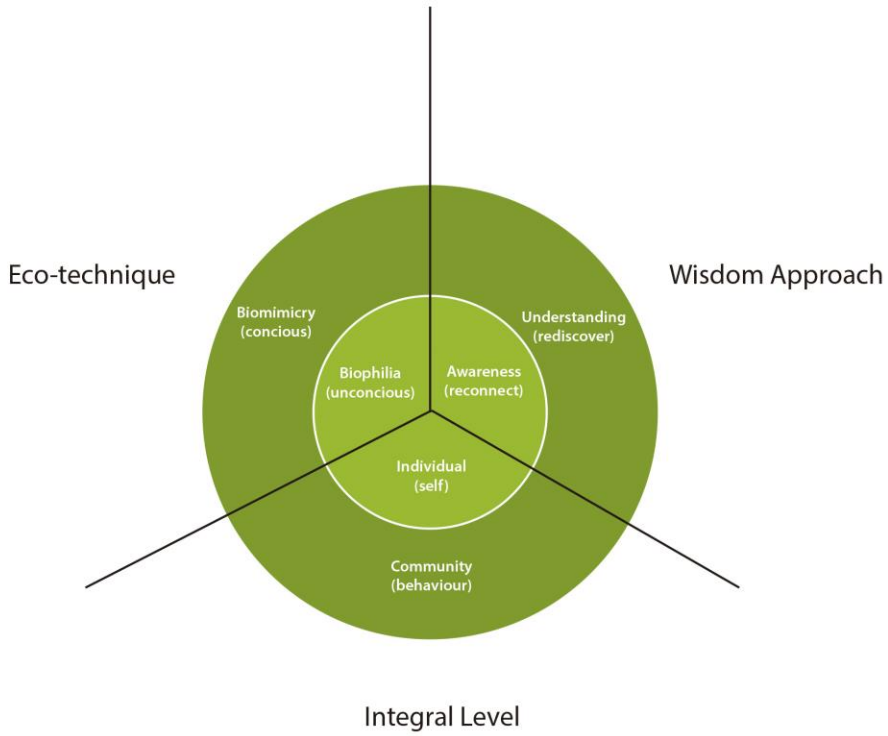

Figure 24. The 'biomimetic practitioner' foundations
As we consciously use the patterns of nature, all will be reflected in our behavior as a community of life, and the biomimetic practitioner will emerge.

Educational institutions and related agencies are now implementing new modules and projects about biomimicry into their agenda. Transdisciplinary methods and tools are available to serve as a compass for a more accurate, sustainable and ethical design. The activities and tools proposed here are a hybrid sample from several years of experience in following a global network of biomimicry. These tools can help design teachers in facilitating ways to motivate bio-inspiration and creativity in students to apply Nature's wisdom. By using these tools and activities in the classroom and observing the quality of design concepts, the teacher can see that we are capable of designing symbiotically, innovatively and ethically alongside our non-human fellows. Nature has been, and always will be, our greatest teacher. If the old design paradigm was driven by industry, economy and consumerism, then the new design should be guided by nature.

Chapter 5. The Resilient Thinker: Changing worldviews to design along with natural systems

5.1 Change by design: Action Stage (Divergent)

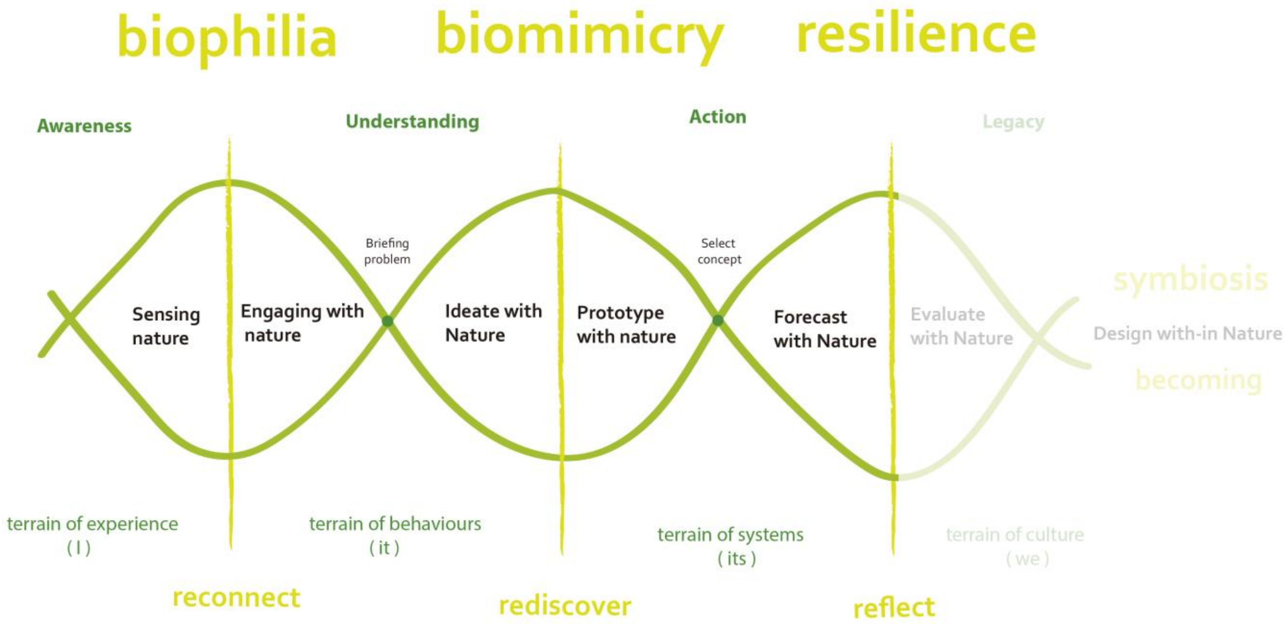

Figure 25. Resilience Action Stage

This stage demonstrates the need to act upon change, but most importantly 'change along with nature' by forecasting and diverging to the different scenarios that our design proposals may cause. Acting on a planetary scale, the SDP will guide us to take the right path as social beings, being capable of visualizing the systemic interactions of a design (product, service, system), and develop resilience against those scenarios.

i. Resilient scenarios: Finding a natural rhythm

At the beginning of the 21st century, tracking trends about the future has become a task for the arts and sciences. One of the challenges is that a narrow mechanistic vision remains in the structure of our social system, affecting the formation of educational institutions, networking participation and technological flux (Kosoff, 2011). Nevertheless, urgent sustainable strategies, about peak oil and global warming, are influencing the way we envision and realise future scenarios. Small-scale production, slow consuming solutions and many other ecological reactions are creating a state-of-transition, and are encouraging us to become a resilient species responding to planetary changes.

In a ten-year forecast titled "*A Century of Transformation, A Decade of Turbulence*", the members of the Institute for the Future (2012) explored six fundamental shifts that will shape the century to come:

1. **'Hyper-urbanization:** From strategies of enclosure to open strategies for the shareable city.
2. **Deindustrialization:** From pipeline infrastructure to agile energy ecosystems.
3. **Dematerialization:** From large-scale manufacturing to just-in-time manifestation.
4. **Social Production:** From institutional wage labour to networked micro-contributions.
5. **Information Intensification:** From information overload to cognitive prosthesis.
6. **Biomolecularization:** From individually responsible intelligent organisms to complex ecosystems of biologically distributed intelligence.'

In their argument, the members of the Institute point out that these transformations will take a century to fully play out and will present us with a turbulent decade, where the 'incumbent paths clash with the emergent paths, and seemingly impossible scenarios may well prove possible'. We can compare this kind of scenario with the one proposed by Meadows (2004) about the 'limits to growth', where industrial outputs, resources, population, food and pollution patterns are part of an interrelated descent. This proposed state of the world is consistent with the ideas of Holmgren (2009), where four energy futures (*techno-explosion*, *techno-stability*, *energy descent* and *collapse)* are based on projections of past trends extending back over a human lifetime, and drawing more broadly on patterns of industrial revolution and capitalism; these trends are all considered part of the broad spectrum of culturally imagined, and ecologically likely, futures.

Greer (2009) distinguishes that future scenarios within an eco-philosophical perspective is a 'search for processes that appear across the range of ecosystems in the non-human world and then look for their equivalents in human affairs'. He merges his conclusions on these patterns into a future where we become sufficiently conscious of considering human activities through '*nature's eyes'*, and how such a perceptive gift is subject to the same changing natural laws. Connected to this notion, Mathews (2011) suggests that we need to 'weave ourselves into nature's synergistic net of desire, wanting what our eco-others need us to want, no amount of clever biomimetic design of our products, services and communications will ensure the integration of those into nature'. We should realize that this cannot merely be done with our own organizational strategies, but by creating a sense of coherence in human intention.

These latent images of a turbulent but descending future raises questions that call for a natural unison. Slow manufacturing and low technology, like many small-scale issues, DIY crafts or traditional farming, are nature-based actions, where the sense of place is demonstrated in local materials, biodiversity richness, spiritual meaning and seasonal adaptation. Local flora and fauna can give us clues on how to mitigate consumerism by harvesting the right quantities of energy, growing materials locally, transforming, distributing and recycling. Ecosystemically, materials are shared with a mountain, with a lake or with an ant. Projecting this sensitive worldview, as discussed in the previous chapters, can encourage designers to innovate-with-nature and generate a *resilient systemic flow*. This kind of flow is represented through the use of rough materials and local techniques, where most indigenous communities have been rescuing and transferring the true wisdom of nature. If we can imprint that wisdom in our designed objects and services, then the opportunity to recognize these *resilient* actions is now.

Resilience is a concept familiar to the ecologist. It refers to the ability of a system, from individuals to whole economies, to hold together and maintain their ability to function in the face of change and shocks from outside (Hopkins, 2008). Today, the resilience concept seems to be inspiring new ethical approaches that look for participation in the act of designing for a living planet. The idea of 'frugal innovation' (Radjou et al., 2012) and 'gentle action' (Peat, 2008) are examples of the kind of resilience flow that can be reflected in the creativity of local gardeners, farmers and craftsmen that mostly come from ancient indigenous traditions. It can now be rescued by design disciplines and merged with suitable techno-digitalization. This vision contrasts with the high specialization that is no longer needed to produce a massive change in human civilization. If civilization, as Gandhi once said, 'consists not in the multiplication, but in the deliberate and voluntary reduction of wants', we can envisage a descent scenario in futurizing techniques that are now acquiring a biologic sense, a coherent natural rhythm for our human endeavours.

The idea of progress or development appears to pursue maximization, sometimes creating fear and disruption. We must begin to conceive a continual state of flow, pulsing in which ever-present but ever-changing provisional products, communications and services will transmute, following a resilient pattern. For example, when we think of a product as a rapidly evolving entity, we start accelerating resources and forcing ideas. Here lies a call to find resilience that reflects that biorhythm. Seeking patterns of regenerativity, or cycles, as in the natural world, can enable the development of ecological wisdom in the designer.

At the boundaries of inconceivable futures, planned and emergent information needs to be connected into an all-mapped world, where networking communities of expertise and non-expertise merge and respond in the middle of complex anthropocentric efforts. Regarding the contemporary need for resilience, Tidball (2012) highlights that 'when facing technological mistakes or natural disasters the human-nature dialogue appears, promoting resilience and linking individuals, communities or populations organically'. This idea is not just a matter of restoring, preserving or sustaining, but of feeling the Earth as a truly crafted entity that *changes along with us*.

Being sensitive as collective beings to our ever-changing planet needs to be part of new creative schemes. As a co-operative/altruistic species, we know how to empathize, exchange information and most importantly, adapt and mitigate surprises and shocks to fit into a world of continuous change. Thus, the response of any system to shocks and disturbances depends on its particular context, its connections across scales, and its current state; reflecting on how things are complex and ever-changing is to respond with resilience thinking (Walker and Salt, 2006, p. 1). Focusing on this concept, we know that human society is complex but adaptive. Therefore, acknowledging this complexity of systems, and the changes that we can feel within a bigger system and our eco-selves, can lead us to become a resilient society (Cote and Nightingale, 2012), and by doing so, we can become resilient thinkers.

The notion of systems thinking inbecoming resilient thinkers is of a paramount importance. Today, the capacity to focus on simple systems will always lead us to find interconnections or to find the complications that systems may cause. On the other hand, if the system becomes too complicated, the only solution is to deconstruct it, not just analyze its basic functions. This dialectic and systemic way of approaching a problem is one of the complex challenges that designers, scientist and engineers are facing (DeVries, 2006).

Future-orientated thinking and forecasting are intimately related to the concept of resilience. As we foresee or plan for various scenarios, positive or negative, we are acquiring resilience-thinking knowledge. Designers are always looking for trends or new ways to innovate, evolve or upgrade. We can better respond to each scenario if, as individuals and collective beings, we become reflective enough to recognise the constraining forces that are beyond our control. But how we can teach designers to learn to foresee change? One answer is to teach them to map out their design intentions, aligned with the patterns of nature. Change, as a constant of nature, is to recognizing ourselves as a resilient species. This kind of engagement with the community of life is transcending green imperatives and sustainability trends at the design academy. We need to establish the platforms to act upon, in order to forecast and moderate innovation when needed.

ii. From sustainable to resilient?

In the last two decades, the term sustainable development, or sustainability, has been widely used to form a global consensus. The meaning extends to a futuristic approach, defined as `meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Development, 1987). The term has evolved, from a narrow to a more holistic approach.

Palmer (1997) expresses how sustainability and sustainable development are 'fuzzy' concepts because they encapsulate diverse interpretations. He also asserts that time frames for reaching a sustainable society are 'rarely defined', referring to the Brundtl and Commission Report's emphasis on inter-generational inheritance, suggesting that the idea was first conceived to operate over a long period. Due to the problem with time frames, sustainable design initiatives convey the notion that, generating human-centred benefits, add wealth and consumption, without considering generational succession concerning ecosystemic cycles, poses a real threat to planetary health.

Although the definition of sustainability has become explicit in its human focus, encompassing four principles, Futurity, Environment, Equity and Public Participation (See Figure 26), applying these principles is still helpful. The framework indicates, for example, that the notion of futurity contrasts with the position of governments looking for strategies in the next decades, or how economic development is not about resources but about a healthy economy meeting people's needs; we can see that this is still a very anthropocentric vision. Palmer also expresses that most government sustainability strategies include human health, conserving natural resources, scientific (and risk) analysis, precautionary action, consideration of ecological impacts, and the `polluter pays' principle (ibid). Most of these strategies aim to improve resource efficiency, or places too much emphasis on futurity, which puts environment, equity and participation into a non-action level, dissolving the holistic aspect of sustainability.

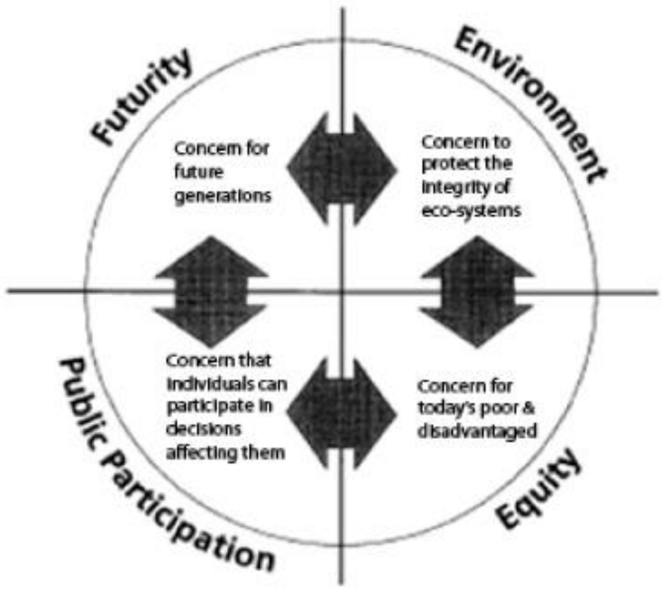

Figure 26. The Four Principles of Sustainability (Mitchell cited in Palmer et al., 1997)

It seems that a 'futures approach' is where the problems of sustainable design often lie. Indeed, it is not integral or based on natural patterns (cycles, processes, interconnections), whereit is needed. In fact, there is an absence of resilient thinking when we become focused on these divisions; (see Figure 27) maps the relationships of these principles, highlighting the weak and/or strong approaches (Palmer et al., 1997). The four principles show how we can differentiate the sustainability concept in a superficial or deeper approach. The fuzziness that created the term sustainability is perhaps useful in the shift toward resilient ways of acting and thinking.

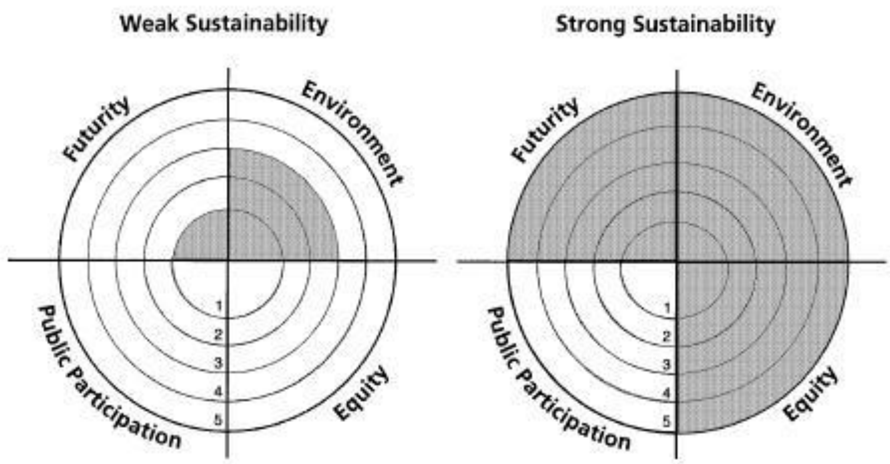

Figure 27. The use of the term sustainability (Palmer, 1997)

Interestingly, Walker and Salt (2006, p. 9,14) have identified some key aspects that recognise a shift from sustainability to resilience,[40] in which constant change, emerging opportunities, systemic approaches and vulnerability are key aspects in identify this shift.

5.1.1 Forecasting change with Nature: Resilience, Global Challenges and Design

There are now clear signs that we have reached the limits of growth on this planet. Peak oil scenarios, latent catastrophes caused by climate change, colony collapse disorder of bees caused by pesticides, the dangers of genetic manipulation, bankruptcy and the doubts of artificial intelligence embedded in robotics, are all signals of a latent breakdown.

While we still have hope in our intentions and believe that our outstanding human achievements have a purpose, we have found that within the pressures of our anthropocentric utopias and inequalities, there are factors that designers must take into consideration:

- Big Data and emergent information needs to be connected into an all-mapped world (Manyika et al., 2011).
- Networking communities of expertise and non-expertise start to merge (Manzini and Coad, 2015).
- Responses to complex anthropocentric efforts, all subject to change, start to follow nature's rhythms (Elling and Jelsøe, 2016).
- Eco-literacy and Techno-literacy development must be in balance (Kahn, 2010).

The present century will be characterized by this decline of growth, as projected by Meadows (2004) and Holmgren (2009), and by the acknowledgement that the planetary level is our major design challenge. Developing a 'sense of alertness' through design has been incorporated into academia, through concepts such as sustainability, ecological design, cradle to cradle (Braungart and McDonough, 2009) and, more recently, with the circular economy (Webster, 2015) or sharing economy (Howard, 2015). One of the

[40] See Glossary: From Sustainability to Resilience

contemporary concepts that has been introduced and is creating positive solutions for small communities, government policies and urban planning in response to this sense of alertness, is the concept of resilience (Hopkins, 2008).

Resilience has various definitions depending on the area of expertise but, to some extent, its principles are the same. As described in the introductory section, 'resilience' in terms of ecology means the ability of a system to absorb disturbance and still retain its basic function and structure. In psychology, it is described as a greater capacity to cope with stress and adversity, and to recover readily after a crisis or trauma (Green and Humphrey, 2012). Some of these definitions express notions of fragility and other negative associations; however, they may also provide positive associations, such as community resilience and a culture of preparedness (Neocleous, 2013). Imagining that everything could go wrong, or projecting that our technological utopias could save us, is a matter of thinking resiliently.

For example, Fleming (2011) describes the benefits of a community perspective with enhanced resilience:

- If one part is destroyed, the effect will not ripple through the whole system.
- There is wide diversity of character and solutions developed creatively in response to local circumstances.
- It can meet its needs despite the substantial absence of travel and transport
- The other big infrastructure and bureaucracies of the intermediate economy are replaced by fit-for-purpose local alternatives to reduce costs.

These benefits mean that by incorporating resilience, we are likely to be more prepared for a leaner future, becoming more self-reliant and aware of our local potentialities. This reinforces the concept of Sustainability. It also moves from the level of an individual, to the level of a community, or to national resilience (National Resilience Institute, 2016). Being in a state of happiness and security is creating movements around the world, like transition towns (Transition Network, 2016) and action for happiness initiatives (Action for Happiness network, 2016).

Hopkins (2008, p. 13) offers the resilience approach based on permaculture principles, which redefines the idea of the traditional, the end of growth and the idea of local community, to incorporate resilience thinking into action. He defines resilience culture as one 'based on its ability to function indefinitely and to live within the limits, and able to thrive for having done so'. Hopkins, and the principles of the *transition movement*,[41] have been reorienting collective efforts in order to break cultural myths.

Putting forth the idea that, in the future, we will be wealthier through continuous growth, or that economic globalization is an inevitable process to which we all give our consent, is not the answer we want to transmit to future generations. Design is ideally placed to break down such cultural myths, to reposition ourselves in relation to the living world we inhabit, and to entice us to view the changes ahead with anticipation of the possibilities we harbour as creative individuals (Irwin, 2015). Design education must therefore strengthen the capacity to form designers who will nourish the world toward and provide abundance in life, now and in the future.

The designer as a resilient thinker must be familiar not only with the definitions of resilience, but also with the principles that a resilient system may have. A resilient system is distinguished as one that is:

- 'Adaptable and diverse and have some redundancy built in'
- 'A resilient perspective acknowledges that change is constant and prediction difficult in a world that is complex and dynamic.'
- 'It understands that when you manipulate the individual pieces of a system, you change that system in unintended ways.'
- 'It provides a new lens for looking at the natural world we are embedded in and the man-made world we have imposed upon it.' (Hopkins, 2008, p. 54)

Along with these ideas, Hopkins defines three ingredients of a resilient ecosystem and its ability to reorganise itself following shocks; these include, diversity, modularity and tightness of feedback. Hopkins provides examples of 'added resilience' that differ from

[41] See: https://www.transitionnetwork.org/ and http://transitiondesign.net/

conventional environmentalism, which leads to a re-examination of best practice and facts that designers might utilize between products, services or performances.[42]

Learning from the concept of resilience, it appears that we have to embrace the unknown and honour change. Polizzi (2014) explains how change, often through struggle, is how we grow and become emotionally and mentally flexible. He also makes it clear that if we can accept change as a universal constant, we realize that our time is best spent learning how to be flexible (emotionally, mentally, and physically) to whatever comes next.

Young and Steffen (2009) enlist six recommendations that may prove helpful in address specific problems of 'Earth Systems Governance and Stewardship' and which inform the need to develop resilience thinking.[43] In comparison, Walker and Salt (2006, p. 11) developed a framework for resilience thinking in which the following three steps need to be considered:

1. Systems perspective;
2. Understanding of thresholds and adaptive cycles; and
3. Apply resilience thinking in the real world.[44]

They conclude that resilience thinking is about understanding and engaging with a changing world, and understanding how and why a system as a whole is changing will give us the capability to work with such change instead of being a victim of it.

Interestingly, design is introduced in the notion of 'resilient design' by The Resilient Design Institute. They define it as 'the intentional design of buildings, landscapes, communities, and regions in response to vulnerabilities to disaster and disruption of normal life' (Resilient Design Institute, 2013). The founders promote a series of principles

[42] See glossary: Resilience comparison in a community
[43] See glossary: Six recommendations for 'Earth Systems Governance and Stewardship'
[44] See glossary: Resilience Thinking Steps

in order to distribute strategic solutions on a building scale, community scale and regional/ecosystemic scale[45].

Some authors point out that resilience needs to be understood in relation to complexity and its interrelation with systems thinking theory. For instance, Meadows (2008) explains that once we see the relationship between structure and behavior, we can begin to understand how systems work and how to shift them into better behavior patterns. Systems thinking, she adds, can help us to manage, adapt and see the wide range of choices we have before us and help us to identify root causes of problems and see new opportunities. So, systems thinking are behavioral patterns, and learning to use them along with design can result in the design of resilient strategies to forecast the effect of a design.

Most of the time, finding leverage points to intervene in a system is a matter of intuition, but we must also learn to push in the right direction (ibid, p. 147). These leverage points are counter-intuitive in complexity, and sometimes we need to work backwards in order to understand them (i.e. deconstruct, dismantle, or even go back to our roots). This designing with resilience is work in progress. We will never know with accuracy the impact of a newly introduced bit of technology, but we can track, compare and study history as design archaeologists. Systems thinking then becomes an important tool. In essence, the designer is a system thinker but needs to constantly reinforce his/her way of approaching systems (e.g. looking for histories, asking good questions, merging with other disciplines). Meadows explains that a system thinker needs to develop 'system wisdoms' by learning to model complex systems and interacting with modellers (Ibid p. 170). She usefully summarizes the principles of a system (ibid, p. 188).[46] Perhaps such wisdom is to learn to read the rhythms of nature, or what the place (local ecosystem) is telling us about design. It is also about collaboration with other disciplines along the art and sciences spectrum.

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[45] See glossary: The Resilient Design Principles
[46] See glossary: Principles of a system

Drawing on the different principles of resilience thinking and systems thinking, we can begin to identify similarities that can lead us to more accurate design conceptualization and evaluation of final prototypes of products, services, messages and interactions. This can be identified as an ecological strategy to change along with our living system, Earth.

5.1.1.1 Resilient thinking tools

a. Visualizing Resilience is Visualizing Systems

There are ways to visualise resilience that can help us to conceptualise the bigger picture. For example, Pharand-Deschenes (2014) describes the Anthropocene as a 'period marked by a regime change in the activity of industrial societies'. He describes that these changes commanded a realignment of consciousness and worldviews calling for ways to inhabit our planet. Along with a team of experts, Pharand-Deschenes uses graphic design and visualization tools to translate scientific statistics and facilitate a worldview in order to become more conscious of the diversity of life on this planet.

A clearly successful example of visualizing systems is the one of 'planetary boundaries' developed by Rockström et al (2009). This framework is based on the need to monitor anthropogenic pressures on the Earth system. The approach assesses the margins within which humanity can operate safely. Their deduction is that transgressing one or more planetary boundaries may be deleterious or even catastrophic due to the risk of crossing thresholds that will trigger non-linear, abrupt environmental change within continental- to planetary-scale systems. The group, based in the Stockholm Resilience Centre, identified nine planetary boundaries: 1) climate change; 2) ocean acidification; 3) stratospheric ozone; 4) biogeochemical nitrogen cycle and phosphorus cycle; 5) global freshwater use; 6) land system change; 7) biodiversity loss; 8) chemical pollution; and 9) atmospheric aerosol loading. Their tentative conclusions estimated that humanity has already transgressed three planetary boundaries: climate change, rate of biodiversity loss, and changes to the global nitrogen cycle (see Figure 28). They acknowledged some uncertainties and knowledge gaps in the data collected, and that filling these gaps would require major advancements in Earth System and resilience science.

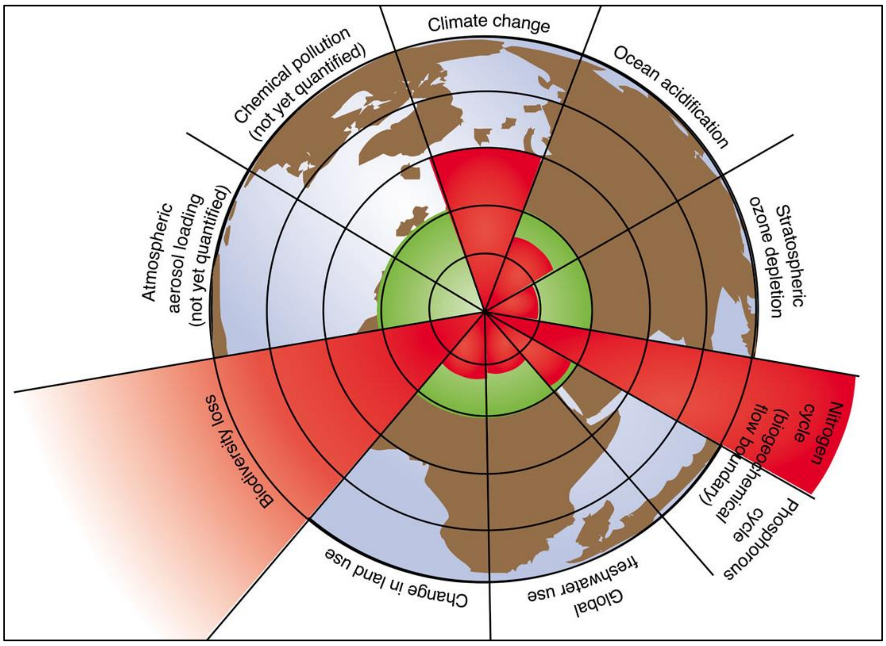

Figure 28. Planetary Boundaries (Rockström et al, 2009)

Rockström recognized that population growth, climate agenda, ecosystem loss and the surprise factor, are the main pressures that our planet, as a living being, is experiencing, highlighting the need to abandon old paradigms of linearity, predictability and control. He explained that the first three factors incorporate most of the data, but surprisingly we need to become more flexible and adaptable to the global change. Rockström identifies three aspects that can help us to achieve resilience:

1. Persistence to withstand shocks or unexpected events
2. Transformability, to move from crisis to innovation
3. Adaptability, or able to understand change

Within the concept of planetary boundaries lays the groundwork for shifting approaches toward resilience thinking. The planning of governance and management, where design is included (manufacturing, infrastructure, services, etc.) then claims to minimize negative externalities, toward the estimation of the safe space for human-natural development – here defined as planetary symbiosis.

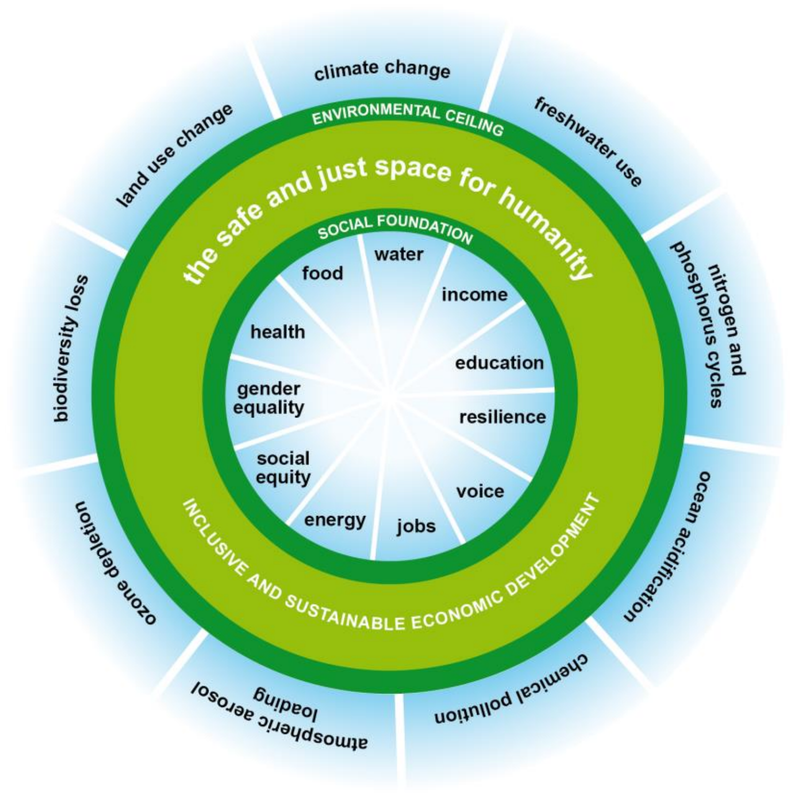

Figure 29. Resilience Doughnut (Raworth, 2012)

The Resilience Doughnut framework (Raworth, n.d.) can help to visualize that kind of safe space. In this model of visualizing resilience, Raworth tries to express that humanity's central challenge in the 21st century is to meet the human rights of all people within the capacity of Earth's life-support systems. The 'doughnut' displays the need to reach a 'safe and sweet spot between social and planetary boundaries'. In Figure 29 (above), the Level 1 of the planetary boundaries is illustrated as the degraded and potential tipping points in Earth systems. On Level 2, the 'social priorities' identified by world leaders are considered unacceptable levels of human deprivation, such as hunger, ill-health and income poverty.

Raworth demonstrates that we have already transgressed at least three planetary boundaries: climate change, nitrogen use and biodiversity loss, 'while over one billion people still lack the means to meet their most essential needs' (See Figure 30). The doughnut framework provides a useful visualization of the 'bigger picture' and where the socio-ecological problems, in particular, have their roots. Using this framework to visualise resilience reinforces the designers' ecological wisdom.

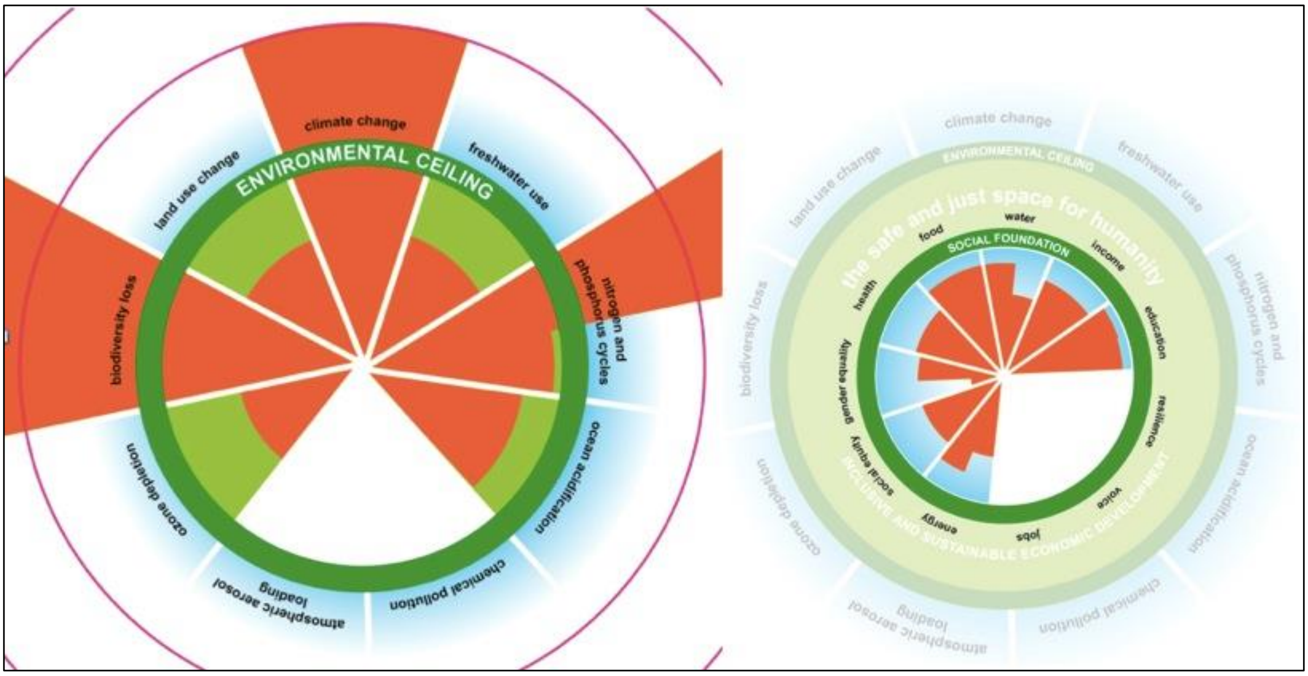

Figure 30. Doughnut and the planetary boundaries (Raworth,2012)

Another example is the notion of Panarchy. In their book "*Panarchy: Understanding transformations in Human and Natural Systems"*, Gunderson and Holling (2001) developed an integrative theory to understand the source and role of change in systems. Here, they explain that different kinds of changes 'transform and take place in systems that are adaptive'. Based on the study of ecosystems, the researchers describe how nature proceeds through recurring cycles that contain four basic phases: 1) Rapid growth (r); 2) conservation (K); 3) release (omega); and 4) reorganization (alpha) as illustrated in Figure 31. In panarchy, adaptive cycles take place at different scales (global and local) of time and space (gradual and episodic, rapid and slow unfolding).

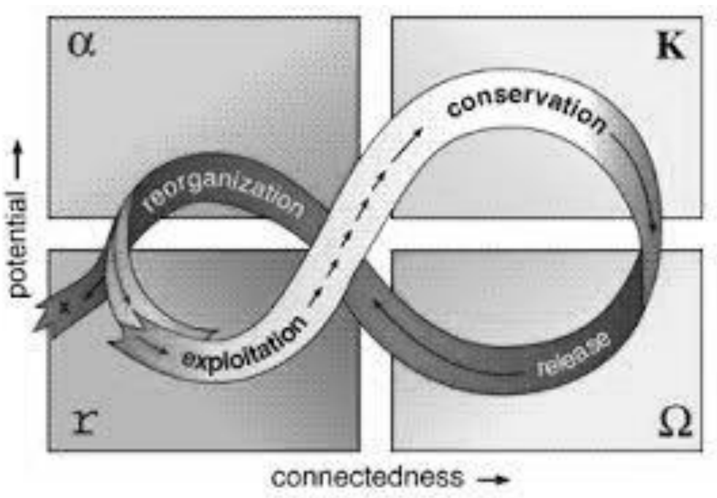

Figure 31. Panarchy dynamic (Gunderson and Holding, 2001)

Panarchy is explained as the antithesis of hierarchy. The original meaning is defined as a set of sacred rules or as a framework of nature's rules. This term is now widely used to visualize systems theory and complexity. The theory of panarchy 'rationalizes the interplay between change and persistence, between the predictable and unpredictable and how panarchies represent structures that sustain experiments, test the results, and allow adaptive evolution' (Resilience Alliance, 2015).

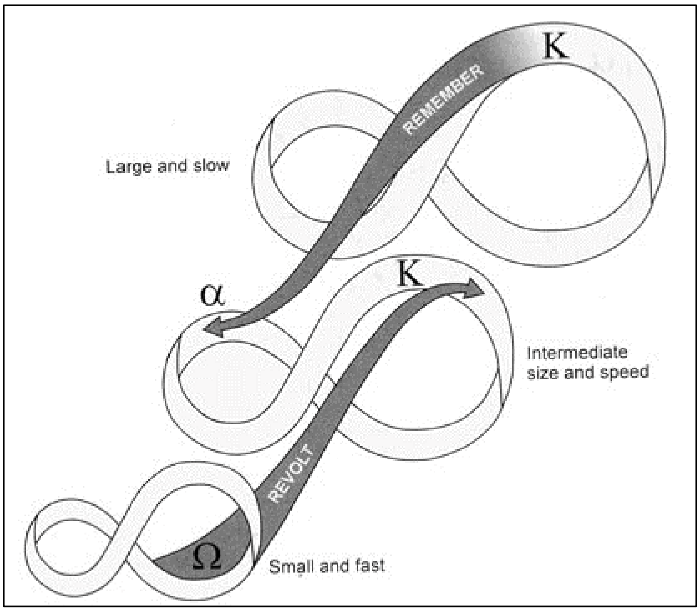

Figure 32. Three level panarchy (Gunderson and Holding, 2001)
In the succession of systems, a "revolt" connection can cause a critical change in one cycle to cascade up to a vulnerable stage in a larger and slower cycle. The "remember" connection facilitates renewal by drawing upon the potential that has been accumulated and stored in a larger, slower cycle.

In Figure 32, the three-levelled system of a panarchy is used to emphasize the connections that are critical in creating and sustaining adaptive capability. Gunderson and Holling (ibid) demonstrate that the number of levels in a panarchy varies, is usually rather small, and corresponds to levels of scale present in a system. Visualizing panarchy is both creative and conserving, and the interactions between cycles combine learning with continuity. The cycle is then represented as the engine that periodically generates the variability and novelty upon which experimentation depends. As a consequence of the periodic but transient phases of destruction (omega stage) and reorganization (alpha stage), here a system's structure and processes can be reorganized. This reshuffling allows for the establishment of new system configurations and opportunities for the incorporation of exotic and entirely novel entrants into the system. Finally, the adaptive cycle explicitly introduces mutations and rearrangements as a periodic process within each hierarchical level in a way that partially isolates the resulting experiments, reducing the risk to the integrity of the whole structure.

The illustration of planetary boundaries and panarchy represents a contemporary notion of resilience thinking, looking at the rhythms of creating, conserving, revolting and finally declining within a continuous cycle. Although it requires deeper study, the idea offers a principle that designers can incorporate into their philosophy of making ecological and social systems. In sum, these kind of visual diagrams (or infographics) are very useful to introduce and form the resilience thinker. Indeed, along with the definitions and principles, the diagrams can be used as educational materials to introduce the third concept of the SDP.

b. Framing wicked problems through systems thinking

Peter Senge affirms that 'the un-healthiness of the world today is in direct proportion to our inability to see it as a whole' (cited in Charnley et al., 2011, p. 2). This perspective requires urgent attention and can only be alleviated by the acquisition of a systems view of life, and by the notion of *symbiotic design* itself (as will be discussed later in chapter 7). One definition of a system is 'to place together, an aggregation of objects united by some form of regular interaction or interdependence, such as body organs that contribute to vital functions' (Backlund, 2000). System thinking owes its origins to holism. The systemic view of life, therefore, incorporates the terms of connectedness, relationships, patterns and context (Capra and Luisi, 2014, pp. 63–69). When ecology merges with the ideas of systems, the ideas of ecological communities and networks, and mutual relationships between organisms, reinforce the idea of super-organisms and then ecosystems. The term ecosystems influences the way we act as planetary beings. By understanding ecosystems and their interconnections, we realize that we can follow the patterns of the ecosystems in which we are immersed.

Systems thinking in design education can help to develop action toward socially complex and global challenges. So, can we address today's problems by studying nature's eco-systemic interactions? Academia is making a big effort to incorporate strategies that draw upon a systems approach (Richmond, 1993). For example, when we use systems thinking the designerhas to analyze and reveal several interactions pointing to desired and/or undesired outcomes. Ultimately, the systems thinker is able to map interrelationships from a totality (Toscano, 2006). As systems thinkers, designers tend to examine the system in a way in which the design is unfolding. What is needed is the ability to map relationships with resilient systems. With this, the designer may be capable of mapping the effects that the design will cause at different levels, from the individual to the planetary. Using nature's lens, or thinking like an ecosystem, is a way to move toward resilient design. We become resilient thinkers, able to redefine the effect we want to cause in the world, adapting or changing conditions.

Design is fundamentally about addressing a need or attempting to solve a problem (Buchanan and Margolin, 1995). The product, service or communication released can have both positive or negative effects, a circumstance described by design theorist as 'wicked problems' (Coyne, 2005). Bruce Mau, in his seminal book *Massive Change* (Boundaries and Inc, 2004), declares that 'for most of us, design is invisible until it fails'. This notion of potential failure will push one to foster a systems thinking approach. For instance, an ecological designer is not the one who creates artefacts or interactions, but is the one capable of visualizing whole system and its complexity. By visualizing the system, its interlinked networks, scales, layers and the spans of time, we can achieve a more interdisciplinary design. Designers must then be taught to connect the interactions and find the right teams of people to define the design system.

A starting point for developing strategies of resilience to overcome the challenge of badly framed designs, and to foresee the goodness or stagnation of a design, is through the mapping of the system and its trends. At some point, stable visualized systems lose their capacity to foresee the change needed and their process becomes archaic, making no changes within a bigger system, thus leading to a collapse or an imminent forced change. Seeing the bigger picture and the narrow picture of a complex design problem in a systemic way is almost like 'pulsing'.

The concept of 'pulsing' comes from the ideas of Baxter and Bruce (2008). They describe it as a 'dynamic technique like breathing; is a systematic technique of in and out'. 'In' focuses on the detailed practice of designing, and 'out' keeps the focus on the context. 'In', to design a product, and 'out', to consider its consequences in the context; 'in' to see the parts, 'out' to see the whole. The authors argue that this technique is 'focusing on detail of a problem or solution inhibits action to step back and see the whole picture'. With this dynamic pulsing act, we develop a systemic view of the problem. This pulsing technique is complemented with the technique of lensing (discussed in Chapter 3, p. 128), looking at the design problem through different lenses, or eyes. The authors conclude that this technique can be used in design education to help students understand the context and consequences of their actions when designing.

Taking into account these ideas of systems thinking, wicked problems, visualizing resilience and pulsing approach, the following activity can help the designer to quickly understand the concept of resilience and its interrelation with a systemic view of life.

Activity 1. Thinking Resilience

Step 1. Introduction to resilience

Activity Description: In order to explain the concept of resilience, the facilitator needs to prepare a visual presentation with definitions of resilience, planetary boundaries, resilient doughnut, panarchy and the related principles of resilience thinking. At this stage, the designer or the groups should have already selected the final design concept.

Step 2. Thinking like an ecosystem

Time: 20-30 mins
Material: Labels, String

Activity Description: The importance of developing systems thinking in design was reinforced with an adaptation of the exercise the "web of resilience", a game used by Rob Hopkins, taken from '*The Transition handbook: from oil dependency to local resilience*' (Hopkins, 2008, pp. 90–1). This game is ideal for teaching the foundations of system interaction and complexity.

Activity Instructions:

- Take the group into an open space, preferable outdoors under a tree, where you should form a tight circle (preferably in groups of 12).
- Using the labels listed on Natural Systems (e.g. Trees, lakes, etc. – See Appendix D.1), and depending on the number of students, you will hand the labels around. Each student will become that organism, wearing a sticker on their top of their chest...
- Using a ball of string, you will ask the students to pass the string around the circle.

Narrative Instructions: You are part of an ecosystem now; using the ball of string, you will find an organism that relates to you, narrating why you depend upon it.

10-15 minutes later, you will ask them to pull the web tight.

Narrative Instructions: Now you can see the complexity of an ecosystem, and how wonderful the interactions are between the parts. Simply put, everything is interconnected. We, like other species, are part of an ecosystem. The network is resilient but fragile. You can also see that some of you are holding more string than others.

Using a plausible narrative: What happens if the hunter removes the rabbits?... (Remove the person with the sticker from the circle), or we decided to drain the lake (remove another person from the circle and continue with the narrative). As you can see the system is falling apart, and will eventually collapse.

To conclude, can you see the impact of design, and all its complexity? Where do the materials come from? What are the effects of an ecosystem? If we continue to over-consume, what will happen to our society – will it collapse?

Note: After they finish the activity, ask them to keep their stickers in preparation for the next exercise

<u>Step 3. Systems Game</u>

<u>Activity Description:</u> Using the Systems Game from Joanna Macy's book *'Coming Back to Life'* (Macy and Brown, 1998b, pp. 119–21), you will introduce students to complex emergent properties of a system, such as, self-organization. The students will be able to identify simple rules and small changes that have significant effects on the dynamics of a system. The students should be able to understand that life is composed, not of separated entities, but of connected relationships. This exercise is particularly good to play after lunch or a presentation, and preferably in the outdoors.

Narrative Instructions: We have said that systems self-organize but how can we experience this? ... Think about two other people in the group, without indicating whom you have chosen.... Move, keeping at all times an equal distance between you and these two people. This does not mean staying in between those two people (i.e. like making an equilateral triangle)... Go, begin moving around...Now you can see a complete chaos as people circulate...you might be able to accelerate as you move, or slow toward equilibrium (playing between 5 to 20 minutes).

Ask the students what they experienced, to begin a discussion.... Ask: Does this game represent an open or closed system? Did you try to organise the process as you moved? Is there any attractor within the group (that caused you to follow a certain color or height)?

See the Research Explorations 5.1.b on this activity.

c. Resilient Rhythm: The need to Change along with Nature

Learning from other species' extinction, adaptation and mitigation of change can give us clues on how to keep evolving as part of nature. Indeed, the acquired thinking and tools of biomimicry can enable designers to use nature's lenses, thereby reframing their worldviews through following the resilient patterns of nature. For example, technological change and societal growth could be considered as adaptive. The need to employ a systems thinking approach in our human creativity is to understand nature's reciprocal resilient schemes. Human beings, oaks, dragonflies or single-celled green algae, are all equally evolved in their own phase. We as a culture are misunderstanding this fact, as evolution in our society is to 'reach constantly the next level, change to another stage to compete or maximize capacities, meanwhile in nature evolution is simply adaptation' (Greer, 2009). While we already know how to emulate nature through biomimicry, it is only by incorporating it that we can achieve a co-evolutionary rhythm.

This biological logic of changing along with nature is the way design must be incorporated into our social behavior and technologies. Acting with this bio-logic, we are able to create a benign design by using software (information), rather than hardware (producing things) whenever possible, to reduce inevitable collisions between imprecise human design and custom-fit natural design (Krupp and Wann, 1994).

Lucchesi (Eggermont et al., 2014a, pp. 89–91) defines this logic by integrating a naturalistic lens (as discussed in chapter 4) that can foster resilience thinking:

> *"One of the foundational attributes of our species' resilience comes from how many lenses or mind-sets we hold as species, and the cultures we often lose are the ones that see themselves as nature, in contrast to western cultures that see nature as external, of which we are not part. [...] Bio inspired design will benefit significantly if we see ourselves as nature and work at a bio-being level of relationship. [...] We can benefit not only from understanding natural systems but also in seeing the human context through the lens of living systems.*

This latter affirmation suggests how biomimetic practices and resilience thinking complement each other and provide a new way to act in favour for a multi-layered system through design. Adaptation to extreme weather, self-organization, unexpected changes and regeneration, among other processes, are all features of ecosystem resilience. If, through biomimetic design, we are open to emulating nature, we as a society are more likely to be able to address most of the problems we face today, such as energy efficiency, food production, climate control, non-toxic chemistry, transportation and packaging, that connect into a homeostatic pattern. Cannon (cited in Steadman, 2008, p. 167) identified homeostasis as 'the capacity of the body to regulate its internal state and for maintaining its physiological stability in the face of disturbances coming from the external environment – for example, drop in temperature, lack of nutrients, muscular activity, metabolic rates etc. – [...] is the process by which we living beings resist the general stream of corruption and decay.' From these definitions, it is possible to deduce that resilience is a conscious homeostatic process that works with the patterns and rhythms of ecosystems. Objects, communications, services and social organization and behaviors have analogies in the layers of our ecosystem's homeostatic processes.

An example of following those patterns is how, as a biophilic society, we have been considering the benefits of ecosystem services, such as detoxification of air and water and assimilation of nutrients by decomposition and pollination. Through collective efforts such as conservation, regeneration or sustainable initiatives, we help to maintain the functioning of ecosystems whilst acknowledging the need to act as an ecosystem. It is the emergent 'its' as in integral theory (Wilber, 2000). This view suggests that we are able to become symbiotic by following natural resilient rhythms. Mimicking ecosystemic patterns involves the development of a biological culture, a concept which is beginning to emerge.

One example of this consciousness is *Permaculture*, which is defined as a 'system for designing people into nature' (Holmgren, 2002) and has been integrated in several communities over the last few decades. Most of its principles are rooted in agricultural traditions and have evolved into ways of 'acting with resilience'. An early definition of the concept is defined as the 'consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs' (Mollison and Holmgren, 1990). More recently, the same authors outlined systems thinking as a way of acquiring the skill of resilience. With this concept, the designer as resilient thinker acquires the capability to facilitate innovative designs that connects with economic models, social behaviors and spans of time.

To illustrate the need for a resilient rhythm in our society, we can refer to some patterns brought by Greer (2009), who recognizes the need to search for processes that appear across the range of ecosystems in the non-human world and then look for their equivalent in human affairs. He considers three patterns, Cyclical patterns, Succession patterns and Evolutionary patterns,[47] to see where our culture is placed. Changing the behavior of a culture to follow natural rhythms could imply an enormous effort, but can also be the consequence of a self-organized complex force. Designing with a focus on elements to change the behavior of culture can only be achieved by connecting the dots of nature's autopoietic needs, our consciousness and a strong sense of resilience. Design as an interdisciplinary connector can trigger such behavior.

Clearly, one of the fundamental questions that arises from this analysis of the ecological shift for the design academy is: How can we equip students with the skills to acquire a systemic view of life and follow a resilient self-organizing rhythm? Is it the collective, as well as the interdisciplinary, effort that brings resilience? Perhaps the answer lies in the way we instruct students to map systems and by making disruption with meaning. This challenge might require not only a collective perspective, but also an integral perspective (its) to acknowledge the system dynamics of our bioculture. It is in the way of performing the rhythm, and connecting the feedback loops, that we are able to respond and evolve at/with the pace of nature.

Therefore, by comparing the resilient rhythm of an ecosystem, a visionary designer, and in this case a rising resilient thinker, will be someone who can understand natural rhythms and subsequently implement the intangible and tangible actions that will ignite resilience. For example, in city infrastructure that adapts to flooding, or behaviors that promote ordered self-organization within a community.

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[47] See glossary: Cultural Evolution Patterns

The following exercise, *'Resilient Island'*, helped to develop reflections toward understanding these inquiries on a resilient rhythm, and helped students to evaluate their design concepts within the bigger context. The *'Resilient Island'* exercise was inspired by the *'Island Project'*, a week-long workshop developed by Professor Seaton Baxter, Terry Irwin and students studying on the MSc in Holistic Science at Schumacher College[48] (Baxter et al., 2007). Adapting the idea into a one-day workshop activity, the 'Resilient Island' activity aimed to include some principles derived from systems thinking, Goethean observation and active design collaboration, as a way to understand resilience thinking as a useful eco-technique. The exercise aimed to help in visualizing the interconnections between our immediate ecosystems, system of values, and the way we are capable of designing and modifying the places and spaces through time.

Activity 2. The Resilient Island

Step 1. Emerging

Material: Bucket of soil, Leaves/Twigs

Activity Description: The concept of civilization and life creation become intertwined. With this activity, we are capable of creating a model of an ecosystem in the form of an island. Self-organization, complexity, emergence and ecosystem interactions are represented in this first step. The objective is to design an ecological system.

Instructions: As a first step, the group is divided into 2 groups. The groups are allocated a large table (or space on the floor) and paper sheets (or cardboard) as a mat on which to build their islands. You will provide each team with a bucket of soil, twigs, leaves and other natural materials, or if you are based outdoors, you could ask the groups to go and find them. The students must select a natural system based on the sticker given in the previous Activity 1 (see Appendix D.1).

[48] See glossary: The island project

Step 2: Making Natural Effects

Activity Description: The aim of this activity is to become a 'natural effect'. During the course of 15-20 minutes, and after coming back from finding natural samples (twigs, mushrooms, leaves, water), the students will create a brand new island by being the 'natural effect'.

Narrative Instructions: Using the sticker from the last exercise, you are the named 'natural system'. The person with the sticker, 'the soil', will pour the bucket in the middle of the mat, which represents the ocean. Observe the terrain topography for 5 minutes. Imagine the island at a bigger scale. Using the tag and the name you have on it, you will become the natural effect, the lake will emerge, the rabbits will be scattered near the grassland. You are life on the island and will allow others to modify the terrain together.

Step 3: Naming the Island: Pulsing

Material: Sketchbook

Time: 10-15 minutes

Description: By undertaking a phenomenological observation and drawing, the students will put into practice the Goethean method and also recreate the idea of 'pulsing' in and out. Observing the island from 'above' (out) provides a bigger picture of the system. Adding details 'in' a drawing, the students will be able to narrow their worldview and focus on the complexity of details.

Narrative Instructions: As an individual activity, you will draw the island, like a map, with all of its features in your sketchbook using the Goethean observation to discover details. Assemble when you feel you have finished and start a collective conversation to name the

Island. Through collective decision making, and taking into account the topography and physical attributes of the island, you will name your island.

Step 4: Making Artificial Effects

Material: paper, string, plasticine, glue, scissors

Time: 15-20 minutes

Activity Description: Provide new stickers with words representing artificial effects and man-made materials (i.e. the development of technology and the evolution of a human civilization). You will give the participants a sticker with a 'human effect' (i.e. composter) that matches the 'natural effect' (i.e. forest) you gave them previously, allowing them to transform the island.

Narrative Instructions: Over the course of the next 20 minutes and by using your new sticker, you will become the human 'artificial effect'. Your aim is to build a community, for example, a community of gardeners in relation to the 'natural effect'. Mock-up a small model of your ideal construction (e.g. temple, greenhouse etc.) and keep in mind that you have to be close to matching the natural resource on your previous sticker. The tools and materials given are limited and this means that you will be able to distribute them or use the 'natural resources to create your mock-ups. Choose your space and mark with little flags if you need more locations.

Step 5: Cultivated Human Ecosystem

Activity Description: At this point the students will have built a construction, meaning that a civilization has arisen and evolved through time. This activity represents how a successful culture has modified the island with advanced techniques, using natural resources of the natural ecosystem.

Narrative Instructions: In brief, explain to the members of the community your role as part of the cultural system and the mock-up you created. Discuss your relationships with the natural environment. Draw a second map in your sketchbook trying to identify your place and the others. You are now part of a successful civilization with the help and complexity of the natural world. You will also learn to follow natural patterns. Feel free to modify anything.

Step 6: Unexpected Event

Time: 15 minutes

Activity Description: In this stage, the idea of shocks and disturbances will be taught. The idea of regeneration after a natural disaster will help to build and reaffirm the idea of resilience. Using the idea of disturbances, the instructor will provoke an unexpected event: volcanic eruption, tsunami or earthquake but will not destroy the island totally (use a stick or shake the table to mimic an earthquake or disaster).

Narrative Instructions: Life on the island is great, civilization is growing and changing, but an unexpected event is coming, a volcano (or tsunami, a drought etc.) that will kill 80% of the population of the island, thus changing the face of the island (creating such a disaster, you will likely notice that some groups will become upset). Please note that you still have hope, you are all resilient thinkers. Start listing the strategies to reconstruct, regenerate or think about measures to protect the island from future disasters (e.g. houses will move to the coast or mountains because it is safer).

Step 8. Emergent Creativity

Activity Description: This step aims to identify how differences make us more creative when collaborating. In this case, collaborative efforts make us more resilient. In addition, mixing techniques or ways of doing it differently give us the idea of creative collaboration. Using different materials from their own 'civilizations' (islands), the students will identify the differences and help each other.

Narrative Instructions: You discover that the same natural disaster has happened in the neighbouring island and you start to cooperate with the other islanders. Find the same expert as on your sticker, and together you will make a hybrid mock-up of the construction you made in the previous step by mixing materials and techniques. Together, you will visit, observe the needs and help to rebuild the island. In pairs, observe the mock-ups and discuss what other strategies need to be completed. List the strategies that you have both created and received from the other islanders.

Note: when you finish this activity, ask the students to write a reflective postcard of the activity for next class and to express their emotions through illustrations, drawings or pictures taken.

See the research explorations (5.1.c) on this activity.

d. Protopias, Utopias, Dystopias: Future Now by Design

Many science fiction books illustrate futuristic visions of humankind colonizing planets. Most of these planets are without life or perhaps with basic life forms. In many of these narratives, one of the first design actions taken by astrobiologists is to analyze similar structures we have on our home planet and start re-producing the same conditions by terraforming; sending living entities such as algae, bacteria or other organisms, to recreate the living conditions. After that, infrastructure and social behavior will perhaps take shape in the same way, or some genetic adjustments may be needed to amend the gravitational differences or defend against the native species. These actions demonstrate not only how easy it is to create such utopic visions, but also the ingenuity and the drive to explore and establish the symbiotic relationships beyond our planets and perhaps with other species.

This sense of forecasting is perhaps one of the most valuable capacities that we have as humans. Nevertheless, we are still a very young species that is still exploring what we want to be. In order to act through design on a planetary-scale system, we firstly need to be capable of understanding the past, the problems we are facing, the relationship with present global pressures and glimpses of the future that we can cast through design.

Studying the Holocene age, we can identify how anthropogenic pressures have evolved. Johan Rockström, from the Stockholm Resilience Centre, recognizes that 'we are the first generation – thanks to science – to be informed that we may be undermining the stability and the ability of planet Earth to support human development as we know it' (Rockström, 2010). Big data trends and analysis show us that our species have struggled and adapted over the last 100,000 years. Through the Holocene age, we started to replicate and understand the adaptive abilities of other living organisms. For example, the way we have been interacting with plants through agriculture, adapting them to different environments and communicating the replication of knowledge through further generations, abandoning the hunter-gathering patterns and moving toward more sophisticated techniques, is a way to replicate that. Figure 33 shows that the ups and downs of changes and adaptations in temperature have been constant and that we have become resilient to those changes as human beings. The Holocene unfolded into the present Anthropogenic age, in where apparently our society is now static nevertheless consuming in higher rates (Mirzoeff, 2014).

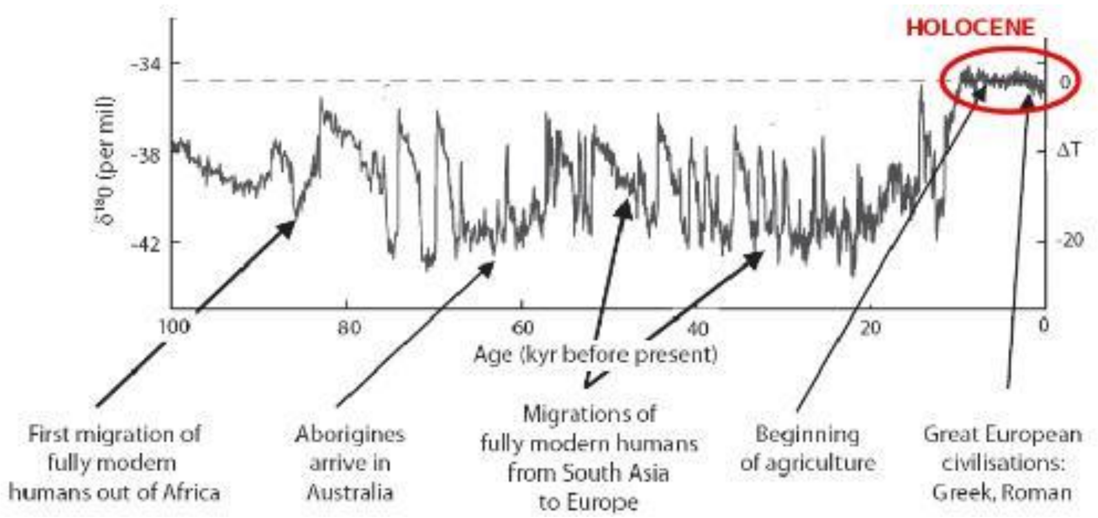

Figure 33. Temperature variability on Earth and the Holocene (Rockström et al., 2009)

The idea of resilience, and the Anthropocene epoch that defines that humans are the predominant drivers of change at a planetary level, is making us rethink and create major movements, from communities, to governments, to the design academy. This means that collective efforts are directed at finding solutions, incorporating methodologies to backcast and futurecast in order to see who we are as species and what we want to be in the future.

Like a pulsing heartbeat, economic stability goes up and down. Our living planet has a rhythm of seasons, just as our bodies follow patterns of life and death, or an ecosystem decays and grows again; this pattern is important to identify.Therefore, we need to learn the limits or mistakes that we may cause, or have caused through technology. For example, do we need to learn synthetic biology and the making of androids to realize our ecological wisdom? Do we need to stop sending rockets to comets and instead look at planetary priorities, such as hunger? These inquiries show that an ethical dimension about futurism must be taken into consideration. Learning from a fictional scenario helps in the exploration of ideas about the future, especially in design disciplines and their conceptual creations. The reality is that future generations might be inheriting fictional or virtual worlds, and the design academy must be aware of the ethics that are derived from such utopias, protopias or dystopias.

Kelly (2014) points out that there are no utopias, where problems are not caused by our technological creations. He illustrates 'how the new technology is that it creates almost as many problems than it solves, a kind of 50/50 scale'. He demonstrates that there is a 'protopian view' that collides with this neutral view, bringing new possibilities that did not exist before; he also argues that technology 'amplifies our power to do well and our power to do harm.' Through the implementation of resilience thinking in design, technology can perhaps give us the choice to carry out small steps to reinforce hope and positive vision, so as to create for good and become conscious about our protopic design proposals.

The design academy has been teaching how to improve things through constant change or redesign, but the academy does not acknowledge, at times, the consequences of such constant innovation. Forecasting these consequences might make us more resourceful and perhaps resilient for the impact of any design innovations. Slight changes in a design, or backcasting, might help us to become more resilient in the development of artifice or policies. Futurity planning is a unique gift that humans have, and designers are well-known for using their creative power to make critical assessments of things to come.

Exploring the various possibilities requires tools that help us to futurecast. The previous stage in the SDP helps us to see biomimicry as a tool to recognise patterns, but with the addition of resilience thinking, it is possible to acknowledge such patterns embedded in the real, and also into a futuristic, context. Ultimately, no one can predict the future if they are not conscious of its history. Arp identifies that the conscious ability to segregate and integrate images into future scenarios is a crucial step in our development as *Homo Sapiens* (Borden and Collins, 2014, p. 322). Scenario visualization accounts for humankind's success as a species. As imaginative creatures, we have the power to influence collective vision. As resilient thinkers, we have the capacity to influence not only a collective vision but a *collective wisdom* that can be manifested as a 'common sense' which influences our free will behavior. Is design, and its resilient ontology, able to trigger it?

For example, Thomson (1979, pp. 8–19) identified that, as 'more people become aware of the problems, more positive action will begin to take place, and the initial future shock will start to lose some of its impact'. Simply put, by undertaking future studies, we might become more human. He also identified that a good futurist 'seeks for trends and limits'; in this way, future studies can act as an 'early warning system, constantly monitoring or dismantling achievable goals'. We know that things will keep progressing and evolving over time, and perhaps the only thing we need to be conscious of is the act of performing one incremental step at a time.

Prediction should be a skill for the resilient thinker. For example, Steadman (2008, p. 248) assesses that 'design as an activity always involves an element of searching, of groping, of trial and error – otherwise it would not *be* design [...] this does not mean obviously that designers fail to predict *anything*, otherwise no machine would work except by chance, and most buildings would collapse'. We must acknowledge how complex is to see the trend of a designed artefact, communication, service or system. Between intuition, uncertainty and collective efforts, only by prototyping the model of the systems in which the design will perform, is what give us hope, and in this case resilience. It is true that shock or crisis can help us to act, but we must at least be prepared with basic skills. Forecasting and backcasting biomimetic design might be as complex as nature in predicting its journey, but at least we know where the inspiration comes from.

For Fry (2008, p. 113), futurism implies a counter 'direction to the existing, industrially inscribed, defuturing grain of the world'. Futuring defines a disposition, a mission and the organizing principles of practicing, and not the stuff of Future Studies (which has been taken as a planning tool for corporate sectors along with conventional methods, such as, forward thinking trend analysis) but means 'giving the self a future' (as the embodied mind acting in the world); in particular, the 'care for the conditions in which the self is in being'.

The methods used for futurecasting are 'not esoteric or difficult to master', they rely upon common sense, good information, and basic logic and a creative flair for visioning the consequences of actions, and even the ability to see interrelationships (Kurtzman, 1984). There are several methods that can help us to think about the future. These include, for example: Forecasting and Prediction, Conjecturing, Scanning, Scenario building, Futurescaping and Visioning. Trend Methods (generational changes affecting past and upcoming events) include: Extrapolation (extending evolutionary trends), Intuitive Forecasting, Scenario Writing (describing conflicting situations), and Delphi Forecasting (probability of social and technical change); whilst other Normative Methods include: Morphological Analysis and Relevance Trees (combination of hypothesis). Figure 34 provides an overview of methods that can be used to design 'futuring'.[49]

Figure 34. Futures methods and techniques

The methods listed above demonstrate the various methodological alternatives in design academia used to conduct assessments that help to identify the impact of a future innovative design. Even with all these methods, we will never predetermine the future, these are not a formula, they are simply a way to rectify whether or not our designs are true or false, good or bad; they are tools to reflect design proposals and challenges.

Making plans is part of the human psyche; ultimately, thinking ahead is what make us human. Forcing things to happen without aknowledging the instincts and awareness of the present may cause circumstances to change wildly. As the Dalai Lama said: 'The best time to correct a problem or embrace a change is now'. Therefore, our utopic designs will become real the instant that we start interacting with them in the present; adjustments will happen one way or another, naturally and without control. Proactively evaluating our

[49] See glossary: Future Methods Features

present context on the goals of a design challenge will define the new circumstances regardless, but with resilience thinking this will happen in a non-rigid way.

The process of future searching implies action on common ground. If we as humans now own the mess caused through the implementation of design technology, there is hope to adjust it and take better action. By recording our natural history, we know where we have been; we need to acknowledge where we are to see what we want along with our living planet, but we must take action to get there. Design, through the resilient strategy expressed here, can help to ease that journey toward symbiosis.

The future generation of designers will at least have the tools to address the paradoxes, dilemmas, flux, change, complexity and new challenges that a design concept might contain. Over-consumption, behaviors, and environmental degradation can be identified as signs of maladjusted, technology-driven thought.

In order to instruct resilient design thinkers in this way, it is necessary to confront the concept of future utopias (visioning) and contrast it with our ancient natural inheritance. The following activity can give a holistic framework of time to embed our design prototypes and begin to evaluate them. In consequence, this will help new designers find a counterbalance to the technologies being released, challenging their planetary ethics.

Activity 3. Forecasting/Backcasting

Step 1. Illustrate the future

Activity Description: When the ideas of resilience are established, it is time to reflect on the bio-inspired artefact and imagine how it will be integrated into human and non-human ecosystems. This is simply an exercise of backcasting and futurecasting design. The students must be aware of how a design concept was used in the past and how it might to act resiliently.

Activity Instructions: Distribute Template 6: Forecasting (See Appendix D.4) to each student. Ask the students to follow the instructions.

The first step is to describe the design in the present: Ask the students to think how the design was 5 or 10 years in the past (backcast), describing the design using bullet points or sketches, and answering the questions inbetween as a guide.

The second step is to ask the students to imagine how the product or service is going to be in the future (futurecast), in the same way describing and asking the questions inbetween. The students must conclude by describing the actions that will need to be taken now, in order to adjust the design concept chosen, thereby reframing other ideas based on resilience.

Step 2: Reflecting on the Future Now

Activity description: Expressing ideas about the future represent a challenge for designers. Convince ourselves that if the design makes sense now and made sense before, this represents a powerful way of becoming a resilient thinker.

Activity Instructions: After the first step is completed, the group should gather along with the tutor(s) in a circle to reflect on their ideas and the possible effects that their design might cause. Ask the individuals to describe their ideas within the group. After this exercise they will be able to make some adjustments to their designs.

See the Research Explorations (5.1.d) on this activity.

5.2 Evaluating with Nature: Legacy Stage (Convergent)

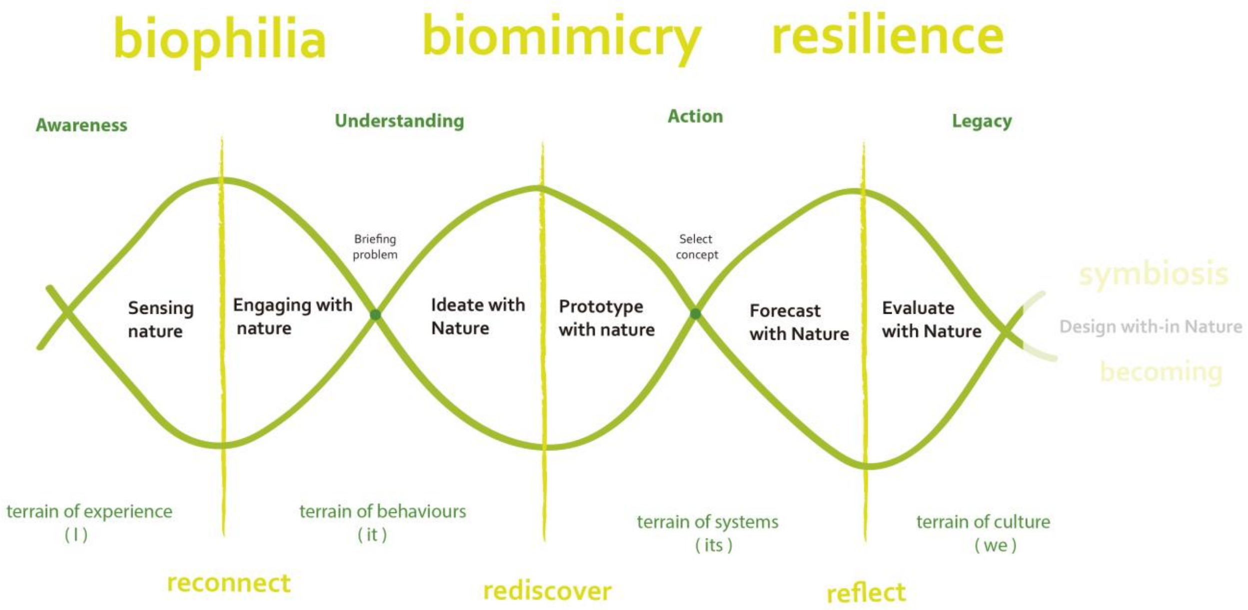

Figure 35. Resilience Legacy Stage

In this final stage, the designer began to question the final concept and began to evaluate it against nature's patterns and social ethics. Here, the terrain of culture (WE) transcends to the planetary level, as bio-culture. The reflections are related to the legacy that the artefact will generate. Meaning and hope are some of the key aspects to reflect upon and will develop into a frugal, gentle and shared positive vision. This final stage converges toward the achievement of planetary symbiosis through design.

i. Life-Meaning design: Natural design ethics to achieve resilience

At the down of the 21st century, our civilization is facing an extraordinary confluence of technology. We may tend to think that we are accelerating our evolutionary rhythms by consuming faster and processing an immense amount of information; technology and collective research is perhaps at its apex, making us a very complex species (Brown, 2016). However, social differences reflect the diversity of worldviews and ways of living dispersed around the world. Indigenous knowledge, vernacular design and other traditional techniques all represent a legacy that we need to rescue for the sake of humankind, a fact that design education cannot ignore.

On the one hand, we have been evolving or changing with useful technologies, such as space telescopes, microscopes, computers and urban infrastructure, instruments that express how we are as humans. On the other hand, our design intellect, interpreted as a gift if offered with gentleness, frugality and gratitude to our planet, will be able to project harmony and peace with nature.

Changing the behavior of a society requires changing customs and habits that have been passed down through generations. Are we able to sacrifice certain secondary needs or emotional predilections? What we need is to satisfy them more gracefully, by 'building health and wealth in more effective, fulfilling and meaningful ways' (Hosey, 2012). One of the problems that we are facing today is that design does not have an integration that favours the technological and the ecological at the same time (Latour, 2004). We cannot abandon the efficiency of the technology central to our times, nor can we abandon the ecological limits of the Earth.

As previously discussed, we require ecological thinking in order to be resilient to technological change, but ecological understanding also needs the technological and creative spark to fulfil human and planetary needs. Our lifestyle is now highly dependent on technologies that harm the environment, yet that are intended to improve the quality of life; for example, transportation systems, packaging and mining. Hosey (ibid) proposes that we need to understand the distinction between 'life support and lifestyle'. He concludes with a critical question: 'Does sustaining life mean just maintaining a pulse, or does it also mean embracing all that makes life worth living?' Drawing upon the work of Hosey, it is clear that we need to incorporate resilient thinking into our dependence on technology. It is crucial to identify technological ingenuity and ecological thinking, simultaneously. In doing so, the designer's integrative action must continuously monitor the challenges of our lifestyle, and distinguish these challenges from life support systems.

Being technologically resilient will perhaps require us to make certain 'sacrifices' and change our behavior; for example, using certain harmful materials, using less, changing our pace or substituting with vernacular design. Being ecologically resilient encourages analysis of such sacrifices more deeply, and as a result meaning that such a way of designing take prescedence for a certain amount of time, and perhaps identify cause and effect for future generations. Resilient thought helps us to embrace our human ingenuity in creating technologies, but also encourages us to question whether it is worth producing.

This idea regarding questioning social behavior and technology resonates with the concept of 'deep sustainability' which aligns with the notion of resilience thinking. Foster (2008, pp. 69–111) highlights the idea of 'fairness to futurity', in which we as a culture seek to clarify our accurate predictions as a form of evaluation of our present habits and lifestyles. He argues that sustainability is 'ill framed as it pushes us to achieve long-term goals and uncertainty, basically a pursuit of a mirage'. In his view, if we need to act now for the sake of the future, we need to follow two principles: *Life-meaning* and *Life-hope*. In our lifetime, we experience life-meaning and take into account that life will go on; it is important to find intrinsic value in what we experience in everyday life, and this is the basic creative power on which life-meaningfulness rests. Life-hope, Foster defines, is our desire to see the 'pure for-itself in consciousness'. Our present society manages energy with anticipation of its embodied circumstances and activities.We know that life will go on, and this will motivate us. When we sense a deep kinship with life itself in the present, we gain hope and meaning in the future. Foster also points out that, in the full recognition of our terrestriality and its claims and responsibilities, we possess an understanding of the unique way in which 'we are conditioned creatures with the unconditional at the core of us'.

The idea of Life-meaning and Life-hope may potentially guide us to being open to becoming a resilient society. Along with the constant changes of styles and trends related to the technologies we create, we must be careful not to lose the spirit of nature as instructor and the pattern that connects our basic needs and ethical desires. As resilience thinkers, designers set boundaries or epistemologies to select the best solutions to technological challenges, seeking the manifestation of a collective ethic which generates an integrative legacy.

Sometimes through technology, we seek to address complexity with a simple design. Within all its complexity, design should aim to provide simple ways of living. We can infer that biomimetic design may begin to defuturing and change our consciousness, not in the physical world, but in the way we think of advancing toward a resilient design ethic. Becoming less dependent on technological fixes and instead on the natural technology that is already here on Earth, such as the metabolism of a forest or the frugal way of living in indigenous communities, is a clear example of designing with resilience.

For example, in the 1970s, John Todd and Nancy Todd expressed that 'the future of humanity was threatened by the loss of biological and social diversity; to address this a new biotechnology needed to be created'. Here, they referred to a neutral term for the word 'biotechnology', without referring to current connotations of genetic manipulation. They were referring to the 'creation of biologically inspired technologies based on an ecological ethics' (Todd, 2006), where each region or community will strive to create projects attuned to natural processes. Their most successful proposals are the *Living Machines*, systems that produce food and clean water and consume sewage matter with the help of plants, fish and bacteria (Todd and Todd, 1993, p. 69). The Todds' work allows us to see the development of a resilient technology through a collective understanding of ecological values and hopes for the well-being of all planetary life.

Who are we without technology? Are design innovations in service and communion with nature? These are some of the questions that are embedded in our ethical ways of designing and understanding our legacy.

These questions are significant in pursuing the commitment to working hand-in-hand with nature and human ingenuity. When we activate our resilience lens with the world, our ethical design intuition gives us the right blueprint. Ultimately, technology must 'make sense', resonating symbiotically with our planet. Our life-hope reactivates and we seek to move forward with purpose. Forced innovation is meaningless; it is enough simply to recognise natural patterns, to harbor a fairness to technology, and to be hopeful as life goes with the flow.

ii. Inheritance: Rethinking our role as designers

The acquisition of our ecological worldview over the last fifty years is helping us to expand our consciousness. Between minimizing the impact of mass production, the devastating use of land, or redefining the quality of life through new technologies, a new ethic has arisen. This ethic centres on asking ourselves as a society what kind of children will our planet be inheriting, or what kind of planet will our children be inheriting? Such questions are not only a dilemma of our current mindset in society; these are matters of ethical legacy.[50] It meansfacing our fears and anger, having hope and, ultimately, acknowledging our faith in the future. Schemes of going green and slow, consuming less and preserving and regenerating our ecosystems, call for a reconciliation of our creative power, through the gentle, through the frugal, through the rhythms of technology.

Post-industrial design through the 21st century depicts existing times. In order to adapt to change as planetary creative memes, the sciences and arts might continue working together along with non-human species at every scale. In doing so, this could help us to acknowledge our symbiotic consciousness.

Many contemporary ecological thinkers claim that 'we need a revolution with the same power as that of the Neolithic agricultural revolution, and as the industrial revolution of the XIX century, a new industrial revolution' (Hawken et al., 2005, p. 1) (Braungart and McDonough, 2009, p. 6). Such a shift without a dialectic exchange between ecological wisdom and technological resilience will not be possible.

We are all participants in a design process, which is life itself. This is the inheritance that most humans forget. This form of social realization is the revolution that is needed,

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[50] The term legacy on this research implies 'leaving a wisdom gift' in the present generation. According to the dictionary, legacy means: inheritance, birth right or heritage. More than physical goods or techniques are needed to provide a worldview in our capacity as makers, doers and collaborators, beyond the human.

belonging in mutual response and change with all life's processes, with resilience. Seeing the mistakes caused by human ingenuity, and the uncertainty that design can makes us increasingly aware of its effects, is a meta-design practice.

How can our current technological ways of design provide the guidelines to become human with-in nature? This is a matter of becoming a gift for the place in which we are living. It also implies a reflection on how, the more we get involved in the technological artifice, the more we need to know about nature's processes.

Another fact is the complex dynamics of pessimism between planetary boundaries, and the provocative dangers of technology that can give justification for our fears about the future. As a motivator, fear must be acknowledged, but its opposite must also be recognized; love, the best ingredient in any design legacy.

Evaluating the final design concept with a set of ethical values about technology, and the principles of life itself, is to embody the well-being of all beings (WE) as bio-culture. The introduction of the legacy concept in this phase of the SDP provides a conceptual framework in which to integrate ethical values about our design tenacity.

5.2.1 Eco-techno literacy to become a resilient bio-culture

We are now reaching a point where our techno-human condition has become incoherent, unintelligible and entirely unhelpful. Technologists Allenby and Sarewitz (2011) usefully point out that 'we have made a world we cannot control'. They also argue that this kind of uncertainty, contingency and incomprehensibility around us requires a shift in our ethical behavior 'by accepting a fundamental cognitive dissonance as integral to the techno-human condition'. Taking this statements into account, the need to help through design is evident.

In this context, technoliteracy can help us to 'become ethical producers' (Kahn, 2010, p. 77). This notion can help us to deconstruct the idea of technological progress, thereby making it more applicable to people's needs and not just their manufactured desires. Khan also suggest that 'alternative techno literacies must become reflective and critically aware of the educational, social and political assumptions involved in the restructuring of education, technology and society'. This notion, then, represents a possible shift in design academia, reaffirming the need to 'reflect' on the way we are teaching and applying design and innovation.

While avant-garde or futuristic design is mostly determined by scientific or engineering accomplishments, the forced discovery and the suppression of ecological thinking is evident. In other words, new design inventions are conceived just to cover the needs in a human context, and when it fails, the recovery takes longer or is subjected again to technological fixes (Beder, 1994), and not the care of the systemic effect of our biosphere. But how can we acknowledge our technological prowess, and all its dark and bright sides, along with the ecological factor that it embodies? The answer again leads us to technoliteracy.

The way we have been educated about our history, and about the possibilities of the future, is as much a matter of techno-literacy and it is a matter of eco-literacy. When we produce new things, we alter the context and begin to appreciate other changes. Regarding this point, Steadman (2008, p. 230) explains:

> *'every move, the appearance of every new bit of work, alters the context in which we understand and appreciate not only that work itself, but in principle all other works as well, this is a* T. S. Eliot *effect in which every major work of art forces upon us a reassessment of all previous works'*

With this last remark, we can see that the problem with society's technological force lies at the point in which the inner constitution of things gets too fast, or when we lose track of the consequences of those things within a system, thereby preventing us from reconstructing its genesis.

Based on the contemporary theories of Manfred Max-Neef et al, Reichmann (2006, p. 225) explains that basic human needs are finite, few, classifiable, universal and objective, and that those needs do not change across time and cultures, but the means do change. For example, food and shelter are satisfiers of fundamental subsistence, and the same applies for study or meditation as satisfiers of understanding. Satisfiers can generate different impacts on the natural system. This comparison leads us to carefully analyze the means versus the ends that, much of the time, technology misuses. Reichmann also identifies that 'needs are not intentional and we cannot choose them, they simply are there', but with satisfiers, we can. In a way, the designer needs to be more focused on the ethics of satisfiers in order to determine which innovation is good or bad in order to establish limits.

Sometimes, the changes that we perceive in technology occur so quickly that when we revisit its predecessors, the only option is to look at the past to achieve innovation. One example is the axe, which is been reproduced with very slight changes, but now we require chainsaw woodcutting vehicles to serve the demands of a growing population. With this example, what does it mean to be techno-literate? Perhaps it is just a matter of ecoliteracy: '*to clear a piece of woodland requires a community effort not a machine effort?*' Techno-ecoliteracy is, therefore, about creating a dialogue between the land and the human; what is needed for both, when it is needed, and why we should care about the woodland cutting intervention, and not an axe or a chainsaw. Reflecting on our technology-oriented contemporary worldview is a matter of resilient design.

Kevin Kelly (2014), one of the most well-known technology theorists, describes how we have just started the making of a technological society. He defines this phenomenon as 'the technium', a large network of technologies working together to support each other; an 'extension of the same forces that self-organized into life'. In the same way that certain technologies depend on other technologies to make things happen, society should become mutualistic but resilient. Another idea of such technology-orientated thought is the notion of 'the Noosphere', defined by Pierre Teilhard de Chardin as 'the human planetary layer forming outside and above the biosphere' (Morrison et al., 1997, p. 177). This kind of external self-organized layer determines how significant technology is in our contemporary worldview. It helps to identify the ethics of creating, and our dependence on it.

When we face such complex ideas as the Technium and Noosphere, designers need to be prepared to analyze their own innovative ways, evaluating and reflecting on the impact of technology. For example, the digital technologies we develop are perhaps creating a huge dependency on digitalization that bring about different social behaviors, and by default, generate new moralities. Design, with its multidimensional critical ecological focus, can help us to ethically identify those layers.

Another illustration of the technologically biased thought is that, over the years, the scientific method has been changing the way we perceive technology and, more importantly, the way we think and practice design. Kelly points out that the scientific method 'is a process with many ingredients, and is still undergoing evolution refinement and advancement' (ibid). Interestingly, Kelly also suggest that technologies are bio-inspired:

> *"In a certain sense the collective mind of an anthill or termites can make a skyscraper. It's kind of external phenotype. You can have birds weave. They do weave. They weave nests. Beavers engineer dams, and that just as we had an external phenotype that we made with our own minds, we made technology and tools. It's anything that's being produced by our minds, and that would include not the individual works of art but the technologies of art, painting and symphonies. Such products are a self-expression of a species but also something that is useful, even if its software [...] 'in the future robots and AI's will be producing something useful'.*

This notion of living technology (i.e. a beaver building a dam) implies that we need to acknowledge the bright side of being inspired by nature in order to develop a world in which humankind can design technology to become a symbiotic and co-evolving living system. This broad notion of symbiosis becomes a matter of both techno-literacy and eco-literacy, where the scientific method and biomimetic ways of thinking help us to become resilient and enable us to reflect on our technogenic impulse.

Many of the problems that our society has are technogenic; for example, oil rigs that cause spills, but also new kinds of extraction or new materials to substitute plastic. Indeed, we must create new teaching and learning methods and strategies to help guide future generations to become resilient thinkers. A change of mindset is needed in human civilization, and is needed to motivate our civilization to adopt a state of reverence for life on Earth, a bio-civilization.

Alvin Toffler's idea of the 'prosumer' usefully illustrates another example of our technogenic civilization:

> *"the prosumer is concerned not just with consuming media but also creating it [...] We're getting back a little bit more to a previous era —the hunter/gatherers— where people made the stuff that they consumed. In a curious way the new technologies can offer us more access to that earlier era. [...] That's true not just for media and intangible things but also for tangible things, and that's sort of the promise of 3D printing and robotics and all these other high-tech material sciences, is that it's going to become as malleable and easy to understand by anyone."*

The best way to manage, regulate and control our technology is 'being constantly vigilant and working with it, using it, and it's through use that we can actually steer it' (ibid). Kelly's paradoxical vision can help us to rethink our role as humans and, more importantly, as designers.

Ideas of biotechnologies begin to dictate the next evolutionary leap – robotic machines, drones, engineered tissues, geoengineering and virtual reality – but also face limits. By thinking resiliently, we are able to slow down or accelerate innovation when needed. We will also be skilled at going back and reviewing past techniques in order to reinvent the future, or in other words, to explore our biological roots and reframe our present technical inventions. Adopting a resilient thinking approach to technology is to embrace such malleability, but to produce it along with nature. In doing so, the designer as a professional can act as a guide to achieving such bio-civilization, conducting not just mere technologies but eco-technologies. Such literacy becomes a matter of *eco-techno-literacy*; simply put, it becomes a matter of understanding the restrictions, feedbacks and costs that that technology may provoke.

Drawing upon the work of Gruen and Jamieson (1994, p. 32), Botkin suggests that 'we can engineer nature at nature's rates and in nature's ways; we must be wary when we engineer nature at an unnatural rate and in novel ways'. Therefore, applying the concept of biomimicry (as discussed in Chapter 4), along with the concept of resilience, becomes fundamental in enhancing our eco-techno literacy. Biomimicry, when applied correctly, is not a technological fix. For example, designing community services or urban spaces according to the changing of seasons, and over long periods of time to satisfy human and natures' needs, can make evident the way in which nature becomes a resilient thinking exercise and a symbiotic exercise, at the same time. This helps to redirect the human satisfiers and act through biomimetic design, in order to respect such human and non-human limits using appropriate technology, which we require as Earthlings.

Throughout this chapter and in previous chapters, opportunities have been explored to use nature as a source of learning to rethink our technological fruition. As a part of nature, we are capable of adapting our technological acumen. The only way to overcome the fear of technology is 'to act' and think in our 'legacy'; expecting the best from us as natural beings will provide life-meaning and life-hope.

5.2.1.1 Conscious resilience practices

a. Gentle Action and the frugality factor: Defuturing technology to achieve resilience

Comparing low technologies versus high technologies is an exercise in confronting the past versus the future. Many of these low technological designs can be found in indigenous communities across the world. Such 'uncivilized' communities can help guide our future experiences and the pace of technological change (Aikenhead and Ogawa, 2007) (Sheehan, 2011). They embody the notion of frugality, whereby local materials, emergence, visioning or even the gift economy emerges in everyday life.

A concept that converges with the idea of frugality is *Jugaad innovation.* Translated from Hindi, *Jugaad* is an 'improvized innovative solution born from ingenuity and cleverness; is a way of acting in response to challenges and spotting opportunities in the most adverse circumstances, and resourcefully improvising solutions using simple means' (Radjou et al., 2012, pp. 1–27). Using everyday objects and resources that are readily available to be recycled, reused or upcycled, or even hybridized to solve a complicated issue, is central to the technique of *Jugaad;* for instance, using empty bottles to create lamps or walls.

The principles of *Jugaad*[51] can be used to design or evaluate a concept, and, as the creators refer, they can also help us to build empathy, resilience and frugality. Indeed, when we use our frugal sense, we are open to improvizing by using immediate and familiar elements, responding in a natural flow. Here, the resilience practice can be reconsidered as a tool to focus on the phenomenological responsiveness toward the behavior of our social context.

On the other hand, the so-called high technological advances, such as carbon fibre or graphene, become the synthesis of years of research and are appealing for the designer. But if we look to ancient crafts, for example the use of bamboo and pottery techniques, we notice that this creations comes from years of tradition. For example, carbon fibre is efficient but the cost and use is limited. The same can be seen in global trade and local consuming, but in this case, ethical moderation and mediation is required.

The diversity of indigenous artefacts that are still used in communities around the world indicate technologies that represent the right livelihood and original instructions of a place, in their own natural design. From hand tools to clothing, from housing to ways of communication, the inventiveness that is still alive has been tested; resilience is present. Such vernacular technologies have meaning, and a spirit, that represent a culture. Indeed, they are 'tools for conviviality' that balance both cultural and natural limits (Kahn, 2010, pp. 64–5). The elegant frugality that indigenous communities demonstrate is a virtue that the resilient thinker needs to acknowledge as a skill and as an ethical value.

Another example of the frugal factor is in the culture of land stewardship and the codes of social behaviors found in Amish communities (Wetmore, 2007). Behavioral models in design are also being followed through modern ecovillages around the world, which have begun to establish energy, food and design codes in tune with local resources and connected globally to the demand (Birnbaum and Fox, 2014). When ecological wisdom is acquired by a community, the introduction of technology needs to inherently respond to legacy dimensions. Understanding the difference between the two worlds of low-tech

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[51] See glossary: The principles of *Jugaad*

and high-tech helps us to become resilient thinkers.

Another link to this frugal practice is the aspect of gentle action in our worldview. For example, during the energy crisis in the 1970s, E. F. Schumacher (1988, p. 107) wrote a powerful piece entitled "*Small is Beautiful*". In his philosophy, Schumacher attempted to express the gentle way of economics:

> *'Ever bigger machines, entailing ever bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful.'*

Most of Schumacher's arguments highlight the traditional technologies (low-tech) and their capacity to produce well-being, compared to the economic and social problems that high technological procedures cause. This gentle way of living is an ethical turning point that we must continually consider when undertaking the formation of designers. Are these gentle values incorporated into the mindset of design students? Drawing on Schumacher's ideas, we must consider the role that the design academy must play in terms of orienting toward the gentle action.

Peat (2008, pp. 141–72) proposes the idea of gentle action to evaluate our selves and organizations, in order to generate a 'creative suspension' to restructure in creative and dynamic ways, following a more natural creativity and tacit knowledge. By evaluating with nature, we can apply this kind of creative suspension by letting nature inform us of what to do next and refocus our design. Within this gentle action, we must allow a design concept to 'breathe', doing 'action without action'; this means that the patterns of nature will inform us if we continue or if we let go of a design prototype. This way of relating gentle action is compared with the concept of *Wu-wei,* expressed by Peat (ibid. p.142) and Mathews (2011), which questions purpose and acknowledges that there is nothing new to be designed.

When we encounter gentleness in a design, we also find humbleness. In '*The Great Dictator*' (Chaplin, 1941), Charlie Chaplin expresses this concept: 'we think too much and feel too little. More than machinery we need humanity. More than cleverness, we need kindness and gentleness.' This indicates that gentle action becomes important when technologies or new designs are introduced. The following statement from Hall (2011, pp. 269–270) also represents the need for 'slow design', retrofit or degrowth, aspects that the resilient thinker must question in their design proposals:

> *'Because many of our modern technologies produce 'personal' devices that collapse time and manufacture urgency – faster computers, phones that makes us perpetually reachable, writers of constant thoughts, webs of interaction that vastly increase common knowledge, yet somehow deprive us of that apprenticed learning that leads to wisdom; this digital haze obscures our view of the future and keep us focused ever more relentlessly on the present, with ever more insistence on speed as a virtue in and of itself'.*

Forecaster Paul Saffo (1992) proposes that '...the reason life feels so much more rapid today is not that individual technologies are accelerating. It is not that things are happening more quickly. It's that more is happening simultaneously.' He also outlines that the way to thrive amid all this change is by 'gaining a larger perspective'. This means that when we study indigenous crafts (low-technologies) and contemporary design (high-technologies), we may think that a clash will happen; nevertheless with a holistic perspective, the opportunities for innovation emerges, slowing down the scales of design in a positive way.

Defuturing means going back to the past to inform the future, in the present. This way of redesigning past technologies implies rescuing the indigenous wisdom or in essence uncovering the natural pattern of evolution of a given design task. Therefore, retrofitting or regenerating technologies will become an imminent skill for the new profile of the designer, who, as a resilient thinker, will be able to identify more design values.

Remaking, like retrofitting, embraces not only material change, but changes meaning and status (Fry, 2008, pp. 205–7). Learning the new from the past, or re-considering technological progress, might be part of the task of our bio-culture and the resilient thinker. For example, rural electrification was one of the fundamental means of progress. On the other hand, and if we think of de-electrification, it may imply generating the power we need with local means; for example, the available wind, water or solar energy of a place. This frugality and gentleness is a matter of seeking 'appropriate technologies' (Greer, 2011, pp. 149–89) that promote resilience and change in ecological worldviews.

If we look into the old ways of living of indigenous cultures, we see that they have been living sustainably for 35,000 years, following the patterns of nature with freedom (Kahn, 2011, pp. 1–10). Future-orientated thoughts can stress us, causing us to develop technologies that are mainly pushed by global industries. We can keep rescuing the positive vision, not only in our 'technological humanism' where our human values are universally able to flourish (Kahn, 2011, p. 39), but also in our interactions with our natural patterns, as a benchmark for assessing adequacy with resilience, as true eco-technology.

b. Hoping for 'good' design: The ethics of positive future scenarios

Another approach that can reinforce the idea of resilience in the evaluation of design is the idea of optimism. When we are able to acknowledge the empathy and resilience about all living things, we start to notice that nature is always purposeful, even when natural disasters happen (Ridley, 2011, p. 361). Hawken (2010) makes evident the concept of a 'positive vision of the future' and 'unfinished work', connected with the act of citizenship and participation with nature. In the same way, the progression of a design must be contemplated positively and with hope, which will help us to reframe its ethics.

For example, bio-technology is becoming a force that promises to fulfil the needs between human culture and the flow of nature. As a consequence, we become aware as a society of reviewing, hacking or making transparent every process of genetic modification. Taking into account the atomic bomb or the BP oil spill, and similar human mistakes, the necessity to establish resilient strategies to overcome such shocks becomes apparent. It is clear that the resilient thinker requires a sense of alertness.

Fundamental to identifying resilience in design solutions are three basic concepts: 1) the benefits of learning from the mistakes from the past; 2) highlighting the basic needs of the present; and 3) thinking with a positive attitude about the future. These can give us the tools to generate good design. By the same token, our extreme optimism can affect our ways of designing, as extreme pessimism can blind us (Ridley, 2011). This does not mean forsaking positive innovation or removing the value of our critical pessimism; it is about seeking a resilient balance.

We can use our imagination to design for a positive future. If imagination is defined as an 'ability of the individual to reproduce images or concepts originally derived from the basic senses but reflect in one's consciousness as memories, fantasies or future plans [...] these can be rearranged into new images of possible futures; dialogues that may range all the way from regretful ruminations to rehearsals or practical planning' (*Encyclopedia of creativity.*, 2011, p. 13). This definition provides a clue in the myriad of posibilities toimagine a flourishing civilization that puts faith in innovation and collective imagination along with ways of being with-in nature.

A positive approach to this is acquiring a vision of 'what we really want'. When an optimistic design fails or is questioned, we shift to an 'active radical hope' in which our dreams about the future can be achieved. Changing conditions can be forceful, but most of the time they give us the courage to open the window and face reality in order to evaluate legacy in a refined way. As designers, we might feel fear or be overwhelmed by the trouble we can cause. Fear is the necessary consequence of feeling hopeful again, 'it propels us into action' (Whitley, 2009). Whitley also suggests that the 'present moment is the only place for seeing clearly, unclouded by hope and fear'. Vaclav Havel also recognizes that hope is definitely 'not the same thing as optimism. It is not the conviction that something will turn out well, but the certainty that something *makes sense*, regardless of how it turns out' (Havel and Hvizdala, 1990, p. 181). We create visions of what we want though a design concept, and make a plan to produce and test it; sometimes we learn about the prototype as we go, but we also learn to keep hope alive. If it is successful and 'makes sense', it will be used in everyday life and we will become more content.

For Orr (2011, p. 326), authentic hope is made of 'sterner stuff than optimism and is rooted in the truth that we can see, knowing that our vision is always partial. Hope requires the courage to reach farther, to dig deeper, confront our limits and those of nature and dreams'. Following this argument, he writes: 'optimism does not require much effort, since you are likely to win anyway but hope has to hustle, scheme, make deals and strategize'. Orr's ideas show us that when we design we hope and, if we are optimistic, we have the capacity to acknowledge the fear and pessimism that we need to face with courage, in order to achieve good design.

When the resilient thinker acquires 'active hope'(Macy and Johnstone, 2012), it can help us to have 'sense of purpose' and find the shift to create a 'good story' through design. If the design is projected with purpose and 'gratitude for life', resilient thinkers are already doing their best. Making good stories to bring forth bio-cultural principles becomes fundamental. In doing so, every design intention can become a gift to share with future generations.

Worrying about the future is a constant fact, especially in the way we perceive sustainability or other futuristic stories. At the convergence of multiple crises, dreaming positively is the best practice. The rhetoric of these challenges can make us think in a shallow manner, and the only way is to expand is through meaningful action and deep reflection.

Visions, new myths and new stories are creative tools in designing a future to prevent utopias and create abundance. One of these new visions is Holmgren's (2009) proposal on energy futures. He maintains hope and optimism, but also retains the fear and pessimism of collapse. His framework considers the spectrum of 'culturally imagined, and ecologically likely future scenarios over the next century'. Figure 36 illustrates the idea of four different scenarios: *techno-explosion*, *techno-stability*, *energy descent* and *collapse*.

Similar to Holmgren's argument, Greer (2009) supports a creative descent, understanding that such complex interconnected scenarios can help us visualize those scenarios to become a resilient civilization. To some extent, these design disciplines can help create technologies that reconsider a gradual descent or shift and to understand the interconnected effects of such change. The idea of an energy descent scenario makes evident how design is able to change the story for positive collective action, shifting paradigms of technology and ethics of legacy by designers becoming Earth stewards.

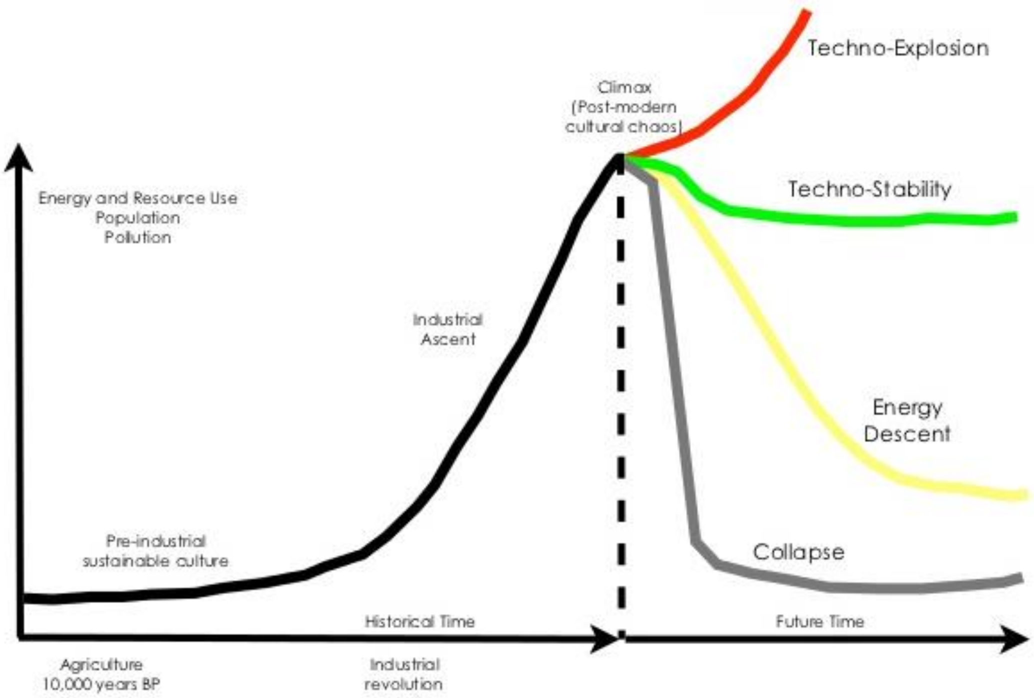

Figure 36. Energy Futures by Holmgren (2009)
In this graph, when we reach the point of climax in the climate crisis, the most creative and positive way forward is the energy descent, not the technological dependence.

Permaculture can be considered another proposal of positive vision. All its principles are related to the concept of resilience. Mollison and Holmgren (1990) developed this philosophy by integrating two core ethical values: 1) 'Humans are a part of the planet and cannot be separated from it'; and 2) 'Humans can be a positive force that leaves things better than we find them'. These two values regard humans as part of the solution, by becoming a responsible species and, as a 'positive force', are able to optimise the disturbances we cause when we produce and consume. The Permaculture approach offers a framework to repair and regenerate both the natural and human world, incorporating three foundations: *earth care*, *people care*, and *fair share*, which are also found in most traditional societies. It also integrates twelve general principles, derived from ecosystems analysis which informs design at the personal, local and regional level.[52] Permaculture also allows for problems to be reframed as opportunities. Therefore, it is a tool for the resilient thinker to use in bringing about a positive future.

[52] See glossary: The 12 Permaculture principles

c. Shared Vision: Interdisciplinarity to achieve resilience

One feature that distinguish us as a sophisticated species lies in our capacity to communicate within diverse groups and to understand our interconnection with other non-human species. This capacity can help us to develop solutions to our wicked problems, and achieve resilience.

Designers similarly innovate with purpose when we collaborate in an interdisciplinary manner. Effective design happens when groups of people not only perform organically, but are intrinsically diverse and are working toward the same goals (Carayannis, 2013). It is in the same way that collective communication found in communities in nature, known as super-organisms, can inform the way we create collaborations (Hoffecker, 2011). Wolley-Barker (2016) examined how the patterns of nature can be used to design resilient collaborative organizations.[53]

We are becoming increasingly interconnected with communities from various disciplines, that influence each other. The expertise of co-designers aiming to shape a desired future becomes fundamental in creating a 'shared vision' and a resonant legacy, where all get involved to maintain a sense of community, and, consequently, acquire a sense of resilience. As we enter an age of increased networking and collaboration, marked by social enterprise, open-sourcing and other phenomena (such as remote groups connected by social media) at different levels of organization, the 'collaboratoriums' emerge. When such collective efforts and the use of bio-inspired design collide, new ecological collaboratoriums can be created.

For example, Vines emphazises that 'the arts alone can't save the world', but makes clear that the discipline can monitor civilization and behavioral guidelines (cited in Zelov and Cousineau, 1990, p. 192). Design is art and science united, it is a translator, connector, generator of balance, as well as many other definitions that imply mediation. Following the same argument, Fry (2008, p. 155) points out that, in the future, we will be

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[53] See glossary: Resilient Organization principles

able to 'make together'. When we sympathize collectively, design ideas become more effective, like an ecosystem. Here, the community becomes the designer itself, in the same way that a collective dream is achieved.

The following exercise concludes the third stage of the SDP. It represents a stage where the design process is used to evaluate the chosen design solutions, in this case evaluating designs against nature's principles and relating those to inspire the creation of a resilient society with frugal, positive and collaborative values.

Activity 4. Evaluating Resilience

Step 1. Evaluating with the Principles of Life

Activity Description: When reaching the final stage in the SDP, an evaluation of the final design proposal becomes vital. Here, the ethics that the principles of life provide are the guidelines for making final decisions and adjustments.

Activity Instructions: Provide the students with a checklist or set of principles to evaluate their final concept. For example, the life's principles used in the biomimicry stage, a set of principles for ecological design or those used in permaculture design, are worth revisiting and presenting to the students. The format used by the Biomimicry Institute is one of the best examples (See Appendix C.5). This format is structured with questions that integrate life's principles by ticking boxes. You can provide your own. With this reflective step, the teams will be able to re-think the effects of their final project.

Step 2. Frugal, Positive and Collaborative evaluation

Activity description: When we use resilience thinking, we develop intuition and team work is more likely to happen. There are a few considerations regarding the action to be taken in evaluating the final concept. Basically, this is to reflect upon our cultural responses when we face a technological dependence. These responses to reflect upon include:

- Ignorance, acceptance or endorsement of it.
- Attempt to control or slow its pace, overall or in part.
- Redefinition of its moral acceptance, overall or in part.
- The gentle action, frugality and positivity.
- We must seek for active hope in our creations.

Present this points along with concepts of frugality, gentle actions, permaculture design, energy futures, positive hope and other related collective action.

Activity instructions: Collaboratively, the groups will reflect on the ethical dimensions of their final proposal. The teacher will ask for a 'reflective postcard'[54] or small essay (half a page long) to individually express the output and their ethical stance, based on frugality, positivity and collaboration to achieve resilience.

See the Research Explorations (5.2.c) on this activity.

[54] A piece of documentation of a project in the form of a postcard which contains an image and text. Developed by Fraser Bruce at DJCAD.

5.3 The Legacy of rethinking design in a resilient planet: Reflective Phase

5.3.1 Resilient Design as Planetary Ethic: Preparing towards symbiosis

Design is one of the basic features of humanity and is an essential determinant of the quality of life (Heskett, 2005, p. 2). With this definition, we can build upon the idea that quality of life implies several possibilities; for example, indigenous groups may have a different understanding of quality of life than an average European's understanding. The same applies to the needs of an affluent individual, or how a young person thinks about life. All this lies in the need for satisfiers and basic needs.

Reichmann (2006) points out that the increase of our creative power and our capacities derives from an increase in our responsibilities: 'Nature, regarding human responsibility, is without a doubt a *novum* regarding the ethical theory and its reflection'. Ecological ethics, or natural design ethics, highlights an important aspect of our urgent cultural transformation, that reveals that nature, at its core, provides guidance toward co-evolution, or planetary symbiosis.

Contemporary design education, and its flexibility that enables an understanding of historical singularities such as pre-industrial society or indigenous crafts, can help create innovation for a resilient society. Our understanding of ethical behavior at a planetary level requires a reconstitution in order to become attuned to a bio-culture. To do so, we require new ecological educational schemes that expand toward the spiritual, political and technological. The concept of symbiotic design (discussed briefly in chapter 1 and to be discussed further in the next chapter) not only represents the unity and mutualism with the living world, but also the power to become one with the world, resiliently.

Finding the common dialectic harmony of collective ideas is fundamental. The differences between economics and ecology, ethics and spirituality, and the arts and sciences relies on the same symbiotic interaction. An example of such symbiosis can be found in the ecological design of a house: we need mathematics to realize the measurements of a house but vernacular techniques are needed to understand our inheritance (as our embodied purpose). The value of quantitative understanding, provided by metrics, is mutually complementary with the qualitative aspects of vernacular traditions. Such symbiosis of these norms has roots in our collective ethic ofdeveloping human technologies and natural patterns.

Quality of life is achieved when paradoxes are acknowledged and we maintain the life-hope and life-meaning of technologies. If these inventions, discoveries or designs do not give direction to life itself, their consequences may be tragic. Such unhealthy ways of responding can be fixed through living patterns and embedded ethics, which may produce harmony, health and happiness in our everyday context and within ourselves. Following nature's humble advice provides an evaluative effort in our present crisis.

Based on this planetary ethic, we can refer to Orr's concept of 'good design', which asks basic questions in order to evaluate the effectiveness of design: 'what is here? what will nature permit us to do here? what will nature helps us to do here?' He also mentions that good design 'becomes part of the social fabric at all levels, unanticipation creates positive side effects and (synergies) multiply' (Orr, 2011, p. 166). Drawing upon these principles and the concepts reviewed throughout this chapter, such as right scale, efficient and frugal use of resources, gentle action, social intelligence and positive solutions, can provide a resilient effort in our society. If we base design on these kinds of ethical collective principles, plus ones that the individual designer recognizes in nature, we are ready to acquire a symbiotic way of being.

5.3.2 Foundations: The character of the resilient design thinker

By becoming a resilient thinker, the designer acquires the capacity to think in systems and using different perspectives and scales; his/her lens, pulses from the narrow to the bigger picture. The resilient thinker learns to understand that every creation will disrupt another system, causing unprecedented consequences; the designer, therefore, seeks to find leverage points to measure and tackle the disturbances influencing the trajectory and thresholds that the artefact, service or communication might cause in terms of behavioral or environmental impact.

The resilient thinker acts in diversity, acknowledging gentle actions and generating frugal innovation by learning to act in the future, and by overlapping systems from the past and the present, understanding the patterns and rhythms of nature. For example, if they learn from ecosystem organization, their designs become part of a networked and common dynamic. Through Nature's lens, the resilient thinker becomes more aware of implementing creative strategies in order to adapt to the unexpected natural phenomena, in other words changing along with nature.

The resilient thinker acts upon the dangers and benefits of design utopias and dystopias, and implements the creation of meaningful scenarios, or Protopias. By creating a meaningful and positive image of the future, the character of the designer is able to become technoliterate, innovate frugally and gently act with hope. He/she is able to critically reflect on the humility between technology and ecology and is open to the diversity of worldviews which are able to change or maintain social-ecological behaviors. For example, scientific advances must be in tune with indigenous wisdom, and vice versa, in order to incorporate well-being into postmodern lifestyles.

The designer can then becomes a 'networked' player, featuring 1) openness, 2) interconnectedness and 3) active collaboration. The designer becomes open because he/she is free to receive and release information, interconnected because he/she affects every intention, and collaborative, due to the connections unfolding between the work of other disciplines – science, engineering, art and design – into collaboratoriums. Such features must facilitate the evaluation of the final design concepts, at this stage seen as a 'reflective and ethical piece' of the process.

Now the design belongs to the individual, but also belongs to the living world. Through evaluation, the resilient thinker becomes a part of a resilient community, which can be defined as 'one that takes intentional action to enhance collective capacity to sustain the good life in the context of turbulence and disruption toward optimum living arrangements' (Hodgson, 2011, p. 89). As resilience thinkers acknowledge a collective consciousness with the planet, they will be able to generate and evaluate good design for a common good.

Fostering legacy in every design intention will make us true resilient thinkers. Being conscious of what our future generations will inherit, and reflecting on the value of legacy, will enable us to foster a bright future, achieved through design action. In summary, the resilience thinker needs to have the capacity to understand the different ethical layers of our society and integrally embrace it. Facilitating resilience thinking to the learner, and with the connection to the previous biophilic and biomimetic approaches, might help to transform the designer's perspective and understanding of those ethical layers. Equipped with this lens, the resilient thinker must be ready to deconstruct the idea of innovation by re-evaluating ancient times versus the contemporary understanding of needs, but taking a planetary ethic into consideration.

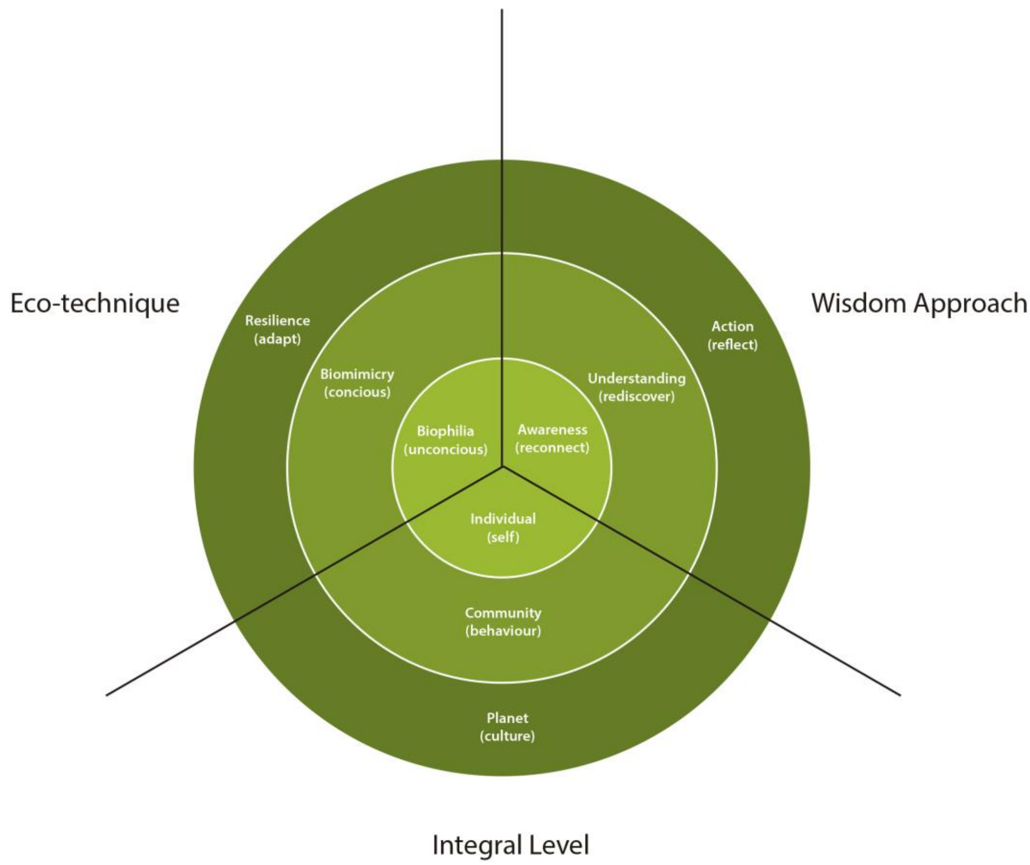

Figure 37. The 'resilient thinker' foundations
As we began to reflect on the state of our culture, we collectively begin to adapt our design intention for the well-being of our planet.

Behaving as the world, (We) – as in integral theory – enables nature to shape us, nature, then allows us to shape her, which necessitates a constant reassessment of design proposals. By teaching resilience, we can expect to form future design professionals not only with an ethical lense, also with an understanding of the importance of being human by bringing health, harmony and happiness with-in nature; in other words developing a sense of coherence and ethical legacy for a collective living being. Figure 37 above shows the foundations of the resilient thinker.

Being able to reflect on the effects of his/her creativity in affirming life beyond human culture through a planetary culture (WE), and by knowing the diversity of futurecasting methods and evaluative ethical principles, the symbiotic design practitioner is almost ready to make transformative decisions. The 'Reflect Phase' of the SDP frames the evaluation stages of the design thinking process, and concludes in the self-realization of being part of a bio-culture, by promoting legacy (See Figure 35 p. 247). In sum, at the end of the resilience stage students will be able to conffirm their concepts and identify weaknesses in their projects, developing a sense of coherence and ethical legacy for a collective living being.

Chapter 6. Symbiotic Design Practice: Becoming with-in our living world through design

6.1 Transcending togetherness: Designing symbiotically

i. The Symbiotic Worldview: Igniting a Symbiotic culture

Finding the harmony between nature and culture is one of the biggest tasks of the ecological designer. Yet we often frame *nature* and *culture* as binary conditions rather than as a spectrum of subtle gradations for linking human and non-human life. Some argue that culture does not exist separately from nature, that everything human is as natural as everything else, while others contend that nature no longer exists, having been subsumed by human activity.

In her book Symbiotic Planet, Margulis (1999, p. 2) describes how the theory of endosymbiosis relates to Gaia theory; she states that 'Gaia is just symbiosis as seen from space'. We share a planetary life and we are evolving in a metabolic fashion with other species. In our bacterial ancestors, we find the evidence that we are the work of close mutual interactions. This deep understanding of life's interactions is perhaps what is changing our worldview toward a bio-civilization.

Symbiogenesis – in evolutionary biology terms – relates to the origin of new tissues, organs, organisms and even species, by the establishment of long-term or permanent symbiosis (ibid, p. 8). Magulis' theory also compares deep ecology or wholism, as a paradigm of 'cohabiting in the world' or 'long-term living' (ibid, p. 43). By incorporating design, it is possible that such symbiogenetic structures will determine other kinds of design, such as interspecies design, new kinds of lifestyles where our relationship with biodiversity will determine our morals, and, in terms of evolution, providing us with the next step in evolving with other-than-human species. This does not mean evolving species synthetically to meet the needs of the human species, but rather evoking a collective wisdom in terms of what we want to collectively recognise as part of the nature that we exist within. For example, we begin to questioning the bios: bio-genetics, bio-engineering and other bio prefixes. This is an aspect of design ethics that may be part of becoming *symbionts*.

Deleuze and Guattari (1988, pp. 238–39) propose a non-classification of 'becoming', preferring the term 'involution' to describe evolution between heterogeneous beings. They specifically use symbiosis to explain their idea of 'becoming', where symbiosis can be seen as the underlying basis of their 'creative involution' in relation to alliance. Margulis, like Deleuze and Guattari, notes that every 'individual organism in a species is really a group, a membrane-bounded packet of microbes that looks like and acts as a single individual', which is important to the concept of humans becoming symbionts, and the fascination of both, the multiplicity outside us (macrobiomes), and the multiplicity that is already dwelling inside of us (microbiomes). Symbiosis, then, plays a role in the discourse surrounding ecology, focusing on the ecosystem that makes up the world as a whole.

The notion of the world functioning as one big ecosystem is reflected in Timothy Morton's work and his concept of 'the Mesh', which is set up against nature-culture distinctions, but also focuses on the interconnectedness of existence, seeing this primarily as a co-existence (Adema and Woodbridge, n.d.). Architect Kisho Kurokawa (1994) reveals his practice of symbiosis by depicting the 'Age of the machine' and the 'Age of life'. In relation to the Age of the machine, he criticizes universality, purity, dualism and human superiority; in relation to the Age of life, he calls for a creation of meaning through diversity, plurality and, principally, symbiosis. He differentiates symbiosis from harmony, compromise, amalgamation or eclecticism, in that symbiosis is made possible by recognizing a reverence for a 'sacred zone' between different cultures, opposing factors and different elements, and between the extremes of dualistic oppositions. A second element of his argument is the sense of an 'intermediary space' : a definite thing that does not exist because of its extreme tentativeness and dynamism, but ultimately incorporates opposition. Through Kurokawa's theory, we can perceive the existent friction within the physical and metaphysical, high-technological and low-technological and the arts and sciences, all of which require a mutual understanding within opposing elements, where their ambivalence, multivalence and vagueness are in continuous transformation and metamorphosis, as is the image of nature itself.

Therefore, is it then possible to propagate the definition of *Symbiotic Design*, or at the very least identify designs or practices that can be defined as symbiotic? Are we really becoming a symbiotic culture? If symbiogenesis is the evolutionary change via the inheritance of an acquired set of genes (Margulis, 1999, p. 11), and design is the creative intentionality of the spirit in response to vital needs (personal definition), then objects, systems and buildings can embody symbiotic intention.

The incorporation of this concept into our culture will encourage individuals and communities to be part of a 'common dwelling'- the *Oikos* – in which 'common sense' (Latour, 2004, pp. 180–184) will appear as the need to self-build a democracy with human and non-human societies, expressing that we will be at the service of Nature, as Nature is now at our service. This kind of participation, in a cosmopolitan sense, lays the acceptance of a new worldview that can be expressed through the *logos and praxis* of symbiosis.

The proposal of *Symbiotic Design,* here defined as 'the practice of inhabiting together', may help to reconcile the intrinsic intentionality that human and non-human species have for our living planet. This new, more open path for designing is founded in the notions of biological symbiosis and the symbiosis of worldviews.

In the field of biology, the idea of the living world as a 'co-operative enterprise' comes from the idea of *Oeconomy,* first used by natural philosopher Sir Kenelm Digby in the 16th century (Goldsmith, 1996, pp. 243–247). Taking these ideas into consideration, Linnaeus and Johannes Warming studied forms of symbiosis in nature, regarding mutualism as a basic feature of ecological organization. Following many other studies, including those of Roscoe Pound, Howard Odum, Douglas Boucher and Robert May, we can notice that they went to consider organismic interactions and mutualism as conditions for stability. Another definition has been put forth by Goldsmith (1996, p. 258), who concluded that 'co-operation is achieving a common goal and in this way natural systems are homothetic to Gaia'. The world-renowned ecologist Eugene Odum proposed that 'cooperation for mutual benefit, is a survival strategy common in natural systems and is one that humanity needs to emulate' (ibid, p. 242).

The idea of symbiosis – *the living together of unlike organisms* – was coined by mycologist Anton De Bari in 1876 (Douglas, 2010). The original definition described a relationship as symbiotic if it involved dissimilar species, and was constant and intimate. He did not exclude relationships where one or more parts were actually harmed by association. Thus, the approach is divided in mutualism, commensalism and parasitism (Perry, 1990). The inclusion of parasitic relationships has often been left out of discussions on symbiosis.

Beneficial associations make life possible. Humans rely on the healthy interconnections that exist between plants, animals, fungi and bacteria in order to be stay alive. Such relationships can vary; some of them are essential to saving energy, feeding or reproducing. The rainforest is one of the most vivid examples in which symbiosis manifests; we can see this in the relationships that exist in the diverse mycorrhizal networks that provide nutrients for trees and other species, in the protection provided by treeroots and in ants that receive honey, in exchange for housing aphids. Without these different form of symbiosis, life would not be possible (Perry, 1990, p. 9). Even the commensalistic and parasitic aspects are fundamental in one way or another, for example, from lichen to corals and from algae to bees; we are mutually interdependent.

Contemporarily, symbiosis means an interaction between two different organisms living in close association, typically to the advantage of both (Margulis, 1991). Margulis reworked the theory by including the idea of hereditary endosymbiosis (*Endo* from the Latin meaning within); the idea being that the next generation of plants receives the usual hereditary material, and also the symbiont, from its parents. This theory also suggests that the composition of the cell in mitochondria and nucleus evolved from two free-living organisms that came together to form a new relationship (Perry, 1990, p. 12).

In order to ignite healthy and ethical relationships between *techno-biophilic* practices in our contemporary culture, it is necessary to emancipate the meaning of *symbiosis* by valuing the diversity of symbiotic worldviews, where:

- The Eastern and Western defences can consolidate better spirituality;
- The left and right hemispheres cooperate;

- The natural and social sciences come together;
- The mechanistic worldview builds the organic worldview and vice versa;
- The traditional and the high-tech pull together;
- Or where growth and regression are just stages of a transformative cycle.

The term symbiosis is used in our modern society to designate simple and optimal associations between individuals, communities and even products like mobile phones or cars. These relationships are based on an exchange of energy or information, or on economic and cultural exchanges. We also know that we can survive or become more effective when we work together with other species, rather than when we are isolated. As symbionts with our planet and with our own built environment, we need to find ways of becoming cooperative agents; in other words, of generating symbiosis.

Regarding ecology, we can recognize that ecosystems co-exist in different layers of symbiotic interactions and within diverse species:

- 'Predation (+/-): one species benefits, one is disadvantaged.
- Competition (-/-): Each species is affected negatively
- Commensalism (+/0): one species benefits, one is unaffected.
- Mutualism (win-win): Both species benefit from interaction' (Perry, 1990).

Drawing upon these interactions, there may be different layers of *Symbiotic Design*, a form of mutual interaction with design related to the individuals and their collective planetary relationships. A win-win situation might be the best way to achieve *Dymbiotic Design*. This dynamic is capable of shifting our culture to more nurturing way of living, where our values, intentions and emotions become interrelated in the web of life, thereby transforming design students and organizations.

Being in symbiosis may help us to heal the damage caused by the illusion of separation that we still have about nature. This is a neo-naturalistic way of thinking, one that seeks, as expressed by Deleuze (cited in Code, 2006, p. 27), 'to eliminate the traditional dichotomy separating humanity (as subject) and nature (as object).' As we begin to design in symbiosis, humans can feel helpful, useful and wanted as we contribute something to life (Borden and Collins, 2014, p. 351). We find meaning and love as we design for our planet, and in this way, designers can become advocates for generating planetary symbiosis.

If philosophy is defined as 'the art of forming, inventing and fabricating concepts' (Flewelling, 2005, p. 110) and is a 'modest task if one considers the lack of viable conceptual frameworks which are unknowable, undisguisable and unable to animate through action' (Code, 2006, p. 26), then developing a notion of *Symbiotic Design* through a pedagogical method is, therefore, a philosophical response to this research. It is about persuading others to originate new areas of exploration and further action of inquiry in our role as a creative species.

The ideas expressed above are clearly based on a biocentric point of view and perceives the individual organism as the teleological centre of life (Hayward, 1995, pp. 66–67). With an ability to perceive the individual *self* (internal) as a centre of life, one is able to look at the world from a different perspective, one that is strongly rooted in deep ecology and an awareness of a symbiotic consciousness that is embedded in the *we-ecosystem* (external).

It may only be when we reach a symbiotic stage, and adapt it's a metadesign approach, that nature will become a participant and human design will be free and humble. As a result, the anthropocentrism and biocentrism paradox may be dissolved. This idea of a non-anthropocentric ethic places the notion of ecology beyond enlightened self-interest and into an enlivened one, the transpersonal. This provokes meaningful questions such as: What do we want to unfold together with the living world? What do we want to design together within the world?

Within this proposal, more questions araise in the quest to become a symbiotic designer, and to become an ecological design educator:

- How can we consider the transition to a more mindful way of designing that cares about our planet, our community and ourselves as individuals?
- How can we implement solutions found in nature that are applicable to the articulation of design problems?

- How can we integrate design in nature's contexts and everyday practice?
- How can we resiliently manage a multi-layered design problem?
- How can we achieve greater civic involvement of design from an ecological perspective?
- How can we educate designers to become aware of their intentions, the understanding of others (including animals and plants) and the interconnections our planet creates and modifies, as we, as a species, move toward a symbiotic civilization?

It is not a matter of finding new definitions of design, but rather of defining a 'new design education strategy' by providing an ecopedagogical framework, expressed here as *Symbiotic Design Practice (SDP)*. Design education requires an adaptation after being entangled in the post-industrial, consumer-oriented, mediatized and digitalized realms. Lewis Mumford notes:

> *'every social transformation…has rested on a new metaphysical and ideological base; or rather upon deeper stirrings and intuitions whose rationalized expression takes the form of a new picture of the cosmos and the nature of man'* (cited in Goldsmith, 1996, p. 438).

Drawing upon Mumford's thoughts, we can reflect that the philosophical basis of ecological thinking is instigating a revolution, which places humans as gifted beings capable of redefining a planetary culture. Practicing symbiosis in design could became crucial for our generation, which should be educated to create messages, policies, products, services and built environments along with other species that have been shaping life on Earth. These are some of the aspects expected to inspire the philosophy of symbiosis in the development of a new design curricula and related ecopedagogical framework.

The notion of symbiosis lays at the meta-level of design epistemology. It calls for a transition through design, thereby igniting a wiser humanity. A wiser humanity might be one where the image of a promised paradise is the one within which nature wants us to flourish; where the instruments of learning will continue to be taught in deep communion with nature.

If humans are the most adaptable and flexible organism, then a key question to answer is: Do we need to disrupt nature to realise that our creative power is anthropocentric in isolation? If our intention is to evolve as *symbionts*, then we need to rethink design, and not become commensals or parasites, but rather agents of mutualism. What kind of symbiosis 'makes sense' for the designer? We are here to transcend our own ways of creation, 'make-sense together' and recognise that, without other species, what we create has no meaning at all, and ultimately affects our health, harmony and happiness.

ii. With and within nature: Reconciling the idea of designing together with our planet

As discussed, Gaia Theory has been influential in the symbiosis discourse. New scientific models and lines of inquiry come to the fore, challenging spiritual facts that break monotheism and nihilism, and question ideas about our next evolutionary leap (Morrison et al., 1997, p. 199). Gaia Theory, combined with the idea of symbiosis, may help us shift the paradigm in which our contemporary ecological culture is embedded, promoting a new worldview of being alive-in-connectedness, here framed as the idea of bio-culture (or bio-civilization).

If we look at the meaning of 'culture' or 'civilization', we can see that it relates to helping our living planet flourish. Marek (cited in Ceram, 1961, p. 11) recognizes that 'to cultivate, has to do with the tilling of the soil, with making fertile; the value lies in the operation, not in the object to which it is applied'. This definition leads us to see how WE as collective beings become increasingly fertile, a catalyst super-organism.

Margulis (1999, p. 143) discusses that, in a planetary level, humans cannot assume responsibility for shaping the planet:

> *'The planet takes care of us not we of it. Our self-inflated moral imperative to guide a wayward Earth or heal our sick planet is evidence of our immense capacity for self-delusion. Rather, we need to protect us from ourselves'*

What if we learn to design together with other species? Are we able to become more sensorial and connected with ourselves as humanity and with our living environment; in other words, being part of a body-Earth? Can we blossom as a macrobial society, where we express a planetary and regulatory bio-civilization within all biodiversity? The answers to these questions suggest that we can liberate ourselves of our human arrogance.

Beyond the concept of sustainability, we need to create a legacy for the living world through design. Are we conscious of such a gift? Are we promoting our intentional action, that will have repercussions on the way future generations perceive the world? Our symbiotic consciousness embraces a true cosmogony, that *the Earth does not belong to humanity, we belong to the Earth*; or, as expressed in the old Native American saying, *it is not about what kind of Earth our children will be inheriting, but what kind of children our Earth will be inheriting*.

Our living Earth (Gaia) offers many gifts, but are we reciprocating with gifts of our own, such as kindness, gentleness and respect for Her? It seems that we do not need to be protected from ourselves, as Margulis suggests; rather, we need to *identify* ourselves with-in nature and be happy with our own gift, just as the bacteria or the fungi is content. We are part of a collective consciousness, transforming and communicating in multiple languages and for different purposes; we can be described as an elegant symbol of a whole interactive and creative body. We are awakening as a **symbiotic culture**, becoming in tune and aware of many interactions, but we need to be mindful participants and give our best effort. This symbiotic dimention can be regarded as a milestone for ecological design.

Whether described as a 'machine', a 'spaceship', or a 'living being', ultimately the Earth provides nurture for our bodies, regenerate space, allow us our health to thrive, and give us the wisdom to create ecological technologies and true symbiotic interactions, such as interspecies communication. Unfortunately, our contemporary way of thinking is only marginally contributing to creating the symbiotic threshold that is required.

With or without teleological judgment, Gaia theory is a useful ethic. Gaia, in all her symbiogenetic glory, is inherently expansive, subtle, aesthetic, ancient and exquisitely resilient (ibid, p. 160). Margulis argues that the only way in which humans prove our dominance is by expansion. She summarizes her argument with a key ethical inquiry that we face as species: Do we have the intelligence and discipline to resist our tendency to grow without limit? She determines that, the planet will not permit any living organism to expand (Margulis, 1999, p. 161).

Being conscious of our extinction, or our expansion, presents a dilemma. Symbiosis is perhaps an opportunity for our species to thrive as it places us in a *chrysalic* stage, ready to transform our culture. Many species have been in symbiosis along with our specie (for example, corn, wheat and horses), but all beings should be conscious of this creative co-evolution. Our *symbiotic consciousness* is a call for reconciliation , isa way to inhabit the Earth together.

Symbiotic consciousness is the active involvement with-in Gaia's super-consciousness. This idea of symbiosis and consciousness relates toKirsten Kelly's hypothesis regarding symbiotic consciousness, which she defined as 'the accumulator effect of acquired complexity through the evolution of consciousness. It is a conglomeration of the perspectives of aware beings that operate and exist together as one' (Kelly, 2014). Based on the ideas of Margulis and William Irwin Thomson, Kelly discusses notes that bacteria are the origin of our consciousness and that this sets a precedence of autopoietic modelling of life through cooperative behavior and exchange in different layers (ibid, p. 17). Kelly proposes six founding principles of symbiotic consciousness.[55] She expands on one of these principles, by noting that humans co-exist with other species and that we are 'living examples of a superorganism'. *Together belonging*, as Kelly describes, creates a system of belonging that humans could not achieve alone (ibid, p. 49).

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[55] See glossary: Symbiotic Conciounsess Principles

This symbiotic consciousness realization resonates with the concept of **designing within nature**, as we are living **within** – conscious of a super-organism – and we are able to **design with** other organisms – we are designing life together – with no distinction between dominant species; we are part of a mysterious design that is life itself. This type of consciousness, of belonging with our fellow non-human symbionts, is perhaps an inherent biophilic tendency. By incorporating the idea of 'designing together', we can create a sense of coherence for life through mutually beneficial design. We can relate this idea to biomimetic design aesthetics, and an inherent need to mimic the patterns of life which are self-replicating, self-reflective, emergent and morphic, that are reliant upon life's changing environment and relationships.

To acquire this 'sense of symbiotic creativity', or *symbiotic consciousness*, it is fundamental to incorporate an ecopedagogical approach in design education, and this evokes the need for interdisciplinary ecophilosophical facets of design. This means that we, as symbionts, can participate with an ethical and aesthetic *techne*.. This *episteme* lies in our subconscious; it is time to make it conscious. This kind of consciousness can also be referred to as 'natural design', where meaningful cooperation between human and non-human intent converges.

Understanding symbiosis provides an innovative alternative for design disciplines that are now exploring ecological design in more intuitive, integrative and multidisciplinary ways, bringing real solutions in tune with the complex dynamics of our now enlivened culture. This approach also promotes a multidisciplinary attitude by framing a dynamic understanding of how to act and create as symbionts.

Symbiotic Design is, then, an alternative for an interactive and creative involvement in a super-consciousness. Here, the eco-techniques used as a framework, and the concept of symbiosis itself, become fundamental. The novelty generated by the idea of symbiotic design will perhaps be better defined by the lifestyle of the next generation, who may shift the worldview beyond sustainability. Along with ecological design, where *Symbiotic Design* may intervene, is the potential for an effective Gaian strategy. The combination of theories, tools and behaviors that are related to biophilia, biomimicry and resilience thinking, embedded in this ecopedagogical framework, can help to define it as a new kind of metadesign. The *Symbiotic Design Practice* proposed here is a framework for merging these related but different concepts into a design process, which creates the ability to come together with, and within, a living world.

6.1.1 Symbiotic design as legacy (Prime Output)

a. Our Bio-culture: Symbiotic design as philosophy for a new cultural shift

As expressed in chapter 1, the symbiotic worldview reflects the idea of the 'Enlivenment Epoch' (Weber, 2013) and the Ecozoic Era (Berry, 2011), concepts that can help guide us, as design citizens, to a better philosophy for the implementation of symbiotic designs.

The idea of Enlivenment seeks to advance our freedom as individuals and groups; to be 'alive-in-connectedness'. This freedom only comes through aligning individual needs and interests with those of the larger community.This recognition of an Epoch is indeed neo-naturalist, but it offers a 'wild naturalism' (Abram, 1997), one that is based on the idea of nature as an unfolding process of ever-growing freedom and creativity paradoxically linked to material and embodied processes with a more-than-human world.

Weber expresses that the biosphere is also very much related to producing agency, expression and meaning (Weber, 2013, p. 13). Based on new findings predominantly in biology and economics, he proposes that lived experience, embodied meaning, material exchange and subjectivity, are key factors that cannot be excluded from a scientific depiction of the biosphere and its actors. In one of these principles, Weber briefly touches on the idea of symbiosis.[56] This suggest that the Enlivenment vision relates to Gaia theory, Biophilia hypotheses and Deep Ecologydefinitions, and resonates with the focus of 'co-design with and within nature', here defined as ***Symbiotic Design***. The Enlivenment vision, then, is a continuation of our ecological wisdom. Our inability to honor 'being alive' as a rich, robust category of design means that we do not yet understand how to build and maintain a life-fostering, or in this case, an 'enlivened', culture.

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[56] See glossary: Enlivenment Epoch principles

Designing with-in nature enable us to become more bio-civilized, and allow us to express this continuation into the Ecozoic Era,[57] or into a 'regenerative culture',[58] as models for planetary consciousness. The ideas of this new geological age, epoch or new regenerative culture, relate to the argument of transcending the Anthropocene epoch and embracing relevant 'life-embracing terminologies' (for example, ecosystem, biosphere, noosphere, Gaia theory, Autopoiesis, regeneration, transition). These terminologies indicate a need to reinstate our symbiotic consciousness, and by acknowledging them as designers, we can respond and delivera bio-culture.

If we are able to define culture as a collective noun for arts and crafts (including horticulture, gardening, building dwellings, culinary and decorative arts), language and writing (trace and inscriptions) and ritual and exchange, then bio-culture must be defined as an ethical and collective effort to generate symbiotic relationships and infrastructure for the well-being of a planetary being, of which we are a part. The idea of a bio-culture, in this research context, integrates the idea of symbiosis as the unification of our human diversity and all biodiversity. We create a culture of life as we inhabit together, a fact that we are beginning to recognize through the sciences, religion and arts. Here, designing becomes an agency in which we can play an active living role in our practical consciousness and pursue the development of the bio-culture.

Few designers use the term Symbiosis as a design philosophy. One that does is Japanese architect Kisho Kurokawa (Kurokawa, 1997). His argument incorporates the 'theory of intermediary space', which has roots in Buddhist tradition. His interpretation was influenced by the *Metabolism movement* in architecture,[59] a vision comprised of three key concepts: metabolism, metamorphosis and symbiosis (Kurokawa, 1997, p. 58). Kurokawa defines symbiosis as a 'relationship of mutual need while competition, opposition, and struggle continue'. Here, the need for the creation of 'sacred zones' is key. Such zones

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[57] Derived from the Greek words 'Oikos', meaning home, and 'Zoikos', meaning pertaining to living beings.
[58] See glossary: Toward a regenerative society
[59] Movement related to the life-principle of designing cities and buildings with metabolic features in the 1980s.

can be interpreted in the religious tradition and as the merging of social behavior, where the universe and humanity are mutually inclusive.

For Kurokawa, symbiosis not only implies the close relationship between man and nature, but also the merging of other concepts, such as past with future, development and preservation and traditional low tech with advanced technology. In his worldview, personal capabilities, along with the end of universality, are key features in an age of symbiosis. The idea of 'co-living' (*tomoiki*), which he identifies, includes the differences in personalities, while competing, criticizing and opposing aims of cooperating and finding a common ground. Such differences help to appreciate and redefine creativity and mixing and matching such differences connects the understanding of symbiosis (Kurokawa, 1997, pp. 23–25). If we review the synonyms of symbiosis, such as mutual understanding, compromise, cooperation or adjustment, with the Japanese tradition of 'imminent harmony', as in Kurokawa's view, we can identify the value of these concepts in our pursuit of an enlivened culture. He also notes that living in an age of symbiosis will be an exciting time in which the individual will be 'plural and diverse', based on the needs and principles of a collective understanding. Today, we are beginning to realize that our technologies may be inappropriate for the ethno-diversity and time-spheres of non-human beings. Energy extraction, mobility and architecture are slowly being adapted to the bio-regions, while enhancing the local-global culture.[60]

Another author that touched on this concept in his provocative book, *The Symbiotic Man*, is Joel De Rosnay (2000), who envisions a new kind of self-organizing living organism as a result of complex interaction between humans, machines, networks, living creatures and nations. De Rosnay describes that this still-embryonic micro-organism is trying to live in symbiosis with the planetary ecosystem; man-made digital technologies or intelligence are still separate entities. His vision denotes a utopia of a 'symbiotic humanity' that intends to provide direction in a world of 'tomorrow together'. Despite his attempt to create a holistic vision of the future, his hypothetical posture is technocentric.

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[60] One example of this symbiosis is in Mexico, where cow dung is used in the mix of adobe bricks. The cows, fed by the locals, can produce not only the means for fertilizing, but also useful materials. In this simple example, the appreciation of non-human species becomes an aspect of co-living.

Indeed, De Rosnay's approach to cybernetics and biology resulted from the idea of the 'cybiont', defined as a 'new planetary organism aimed at challenging our way of seeing and our participation with life' (p. xiii). This hybrid concept of a symbiotic humanity, as he proposes, involves the externalization of our brains, senses and muscles, live become neurons of the Earth, neurons that humans represent; De Rosnay suggests that we are in this process of becoming a cybionts. His attempt to highlight our role in nature as 'neurons' of the Earth stays in the technological and scientific realm, provides hints of how to approach ecological thinking without abandoning the complex laws of nature. His hierarchical approach, which includes ecosphere, biosphere and technosphere layers, may facilitate a creative way of expressing a philosophy of *Symbiotic Design*, but still in a fragmented way.

De Rosnay defines symbiosis as the link that exists between humans and their artefacts (such as computers), and between humans and their ecosystem. De Rosnay argues that a new complex organization is born by co-piloting our own evolutionary processes, our 'natural artifices' (machines, organizations, systems, networks, cities) and the ecosphere that has barely begun to regulate. Such 'symbionomic evolution', as he calls it, between our living environment and our natural artifice interactions, provides a 'gradual emergence of cymbiont's vital function'.

What distinguished De Rosnay hypothesis is that the material aspect of machines, communication systems and relationships with our built environment are mechanisms of symbiosis between the human technosphere, and should be identified as a macrolife. This must avoid becoming an unconscious parasite in which the internet, computers, and biological manipulation could produce a different of symbiosis. Information industries, bio-industries and ecological industries have generated the arrival of disciplines such as biomimicry, which are beginning to mix with the social and cognitive sciences. These disciplines, as discussed in the previous chapter, may be defining new methodologies and the next generation of technological tools. Perhaps augmented bodies, cyborgs, virtual reality, drones and wireless earplugs will enhance our capabilities, but they may also have effects that we cannot predict. We will never know the benefits of becoming such a species. Becoming such a planetary brain or meta-species, as De Rosnay predicts, may be a key feature of ethical decisions in our future culture.

De Rosnay concludes by discussing the need to continue creating and exploring. Optimistically, he also notes that the challenge of the future will not be technological, but instead will be to reaffirm our human-ness in what we create and inherit; here, sharing, solidarity, temporal harmonization and respect for differences will be the norm, and the new way of life of a symbiotic humanity (Rosnay, 2000, p. 280). We can argue that De Rosnay's paradoxical worldview is valid only if we are able to see ourselves as co-participants with the world and if our arrogance dissolves, allowing us to begin to see ourselves as part of the community of life, where our technologies are gentle and co-evolutionary with non-human species, and which respect our own human functions. This natural adaptation will be a way for us to see ourselves as creative ethical agents. The need to master solidarity and optimistic mutualism through designing new technologies is perhaps the route to follow as our symbiotic consciousness evolves.

Generating symbiosis between our designed actions and Earth's actions becomes a matter of mutual fulfilment, a co-evolutionary process. Here, the individual 'self' and the collective 'self' embody ethical behavior through a systemic organization. For example, molecular electronics (nanotechnology), self-regulating macro projects, the internet of things and de-manufacturing processes, may all be aspects that can connect this systemic organism. Producing carbon fibre versus growing bamboo, the use of maker-bots versus ancient crafts, global trade versus local consuming; all these can be drawn into the paradox of a symbiotic way of designing. When such differences are reconciled, merged or rethought for the sake of our planetary health, the limits of human potential can be pushed to generate designs which address these problems, and this is when design comes alive.

Is it possible then to integrate *Symbiotic Design* as a philosophy? It may be possible, however, we need to learn to reconnect our collective intelligence with our planetary intelligence. It is only until we recover our senses (Abram, 1997, p. 182) and return to our awareness of nature (Margulis and Sagan, 1995), that we will fully become symbiotic humans. Even if our technologies develop into an external sensory body, it will be part of a living structure that must be connected in response to our planetary fellows.

Today, we are focused on a very human-centred worldview, especially in relation to design. We study users, materials, living spaces, habits, emotions and medical technologies; we question human values, but not the intrinsic values of being nature. We feel open to manipulate animals, raw materials and entire ecosystems just for human purposes, to such an extent that our creative nature is vibrant without the consent of, or communion with, other life forms. Is it possible to frame a non-human centred design inquiry? Designing with-in Nature can give hope to cities, bio-regions, endangered ecosystems and, of course, humans. Opening our backyards, parks and even houses to unwanted, non-human visitors is about dwelling together in a more-than-human world.

Such an empathetic transmutation with non-humans can help to place a symbiotic meme within every innovation. This can aid in articulating the problems of human organization. Being with-in the living world allows us to experience other sentient organisms through our intuition, what they feel, plan, think, see, desire, fear, hate and love, all playing an essential role in the evolution of consciousness, and ultimately in the way we change the world through design. The following quote captures the wisdom that symbiotic consciousness can bring:

> *"…What is it like to be a moose? You may trade the word "moose" for your own totem animal, vegetable, mineral, or ecosystem. The point is empathy that generates "wonderment" may be the key to any environmental ethics or sustainability movement worthy of the name.* (Van Horn, 2010)

We need to appreciate how other creatures view this world. Thinking like a plant, like a bee or even as a bacteria is not only an exploration of ecopsychology (Roszak et al., 1995), but an imaginative expression that can help facilitate planetary and individual well-being. A *Symbiotic Design* is also a way to awaken the naturalism that human society leaves behind.

The ways of living in reciprocity will welcome togetherness with other-than-human beings, providing support or serving as monitors of change, just as crows, moss and bees need to be more present around us, mutually supporting life. It will require a psychological change where we identify ourselves, not only as fully human but as transcendental collective selves. We are built of microbiomes as well as macrobiomes, connected with a symbiotic consciousness in one way or another. This understanding needs to point toward a philosophy of an interspecies design, or effectively a 'multispecies design'. We, the ecological designers of the 21st century, are able to rethink the natural history of our planet, narrating it as a legacy of lively conscious interactions. Conversing, inviting, negotiating, playing, making together, and, ultimately loving each other as the multispecies we are, as fellow symbionts. A call for multispecies design is, now, a true *Symbiotic Design*.

A multispecies design creates a civilization of life in which we become aware of mutual needs and common life-interactive ethics. Defining and opening boundaries within all biodiversity will help us to generate a sense of our *multiverse*, within the Universe. Perhaps when we realise just how capable we are of following the patterns of life, we will become ready to explore new worlds and encounter other life forms and cosmic cultures, like many of us dream, without abandoning the ideas of collectivism. Or perhaps we will simply need to realize that life here on this Earth, right in this moment, is what matters as a true philosophy of life.

Recent expressions of such symbioticism by contemporary designers can be found in the conceptualizations of Luc Schuiten (see Figure 38 below) and Vincent Callebaut (see Figure 39 below), who picture a future of archibiotic infrastructures. Their examples, and many others not included here, portray a vision of the ethics and aesthetics of symbiosis.[61] The symbiotic aestheticism that we are able to promote through physical design is based on our ability to connect our senses. It is an intuitive state that 'feels' the rightness of a design because it has aesthetic but also ethic integrity.[62]

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[61] These concepts and other related expressions, like in Figure 40. Gardens by the Bay Singapore (various firms) and Biodiversity Bridge Netherlands (unknown author) as examples of symbiotic designs and were collected and used in the lectures and workshop interactions on symbiosis.

[62] Examples of such symbiotic livelihood can be found in bio-regions where indigenous people demonstrate through land-use, crafts, conservation, collective rituals and communion with other non-human living beings to create and share spaces. Moderate resource extraction or killing animals, respect for sites or the creation of special constructions to be inhabited by other-than-human beings, are reciprocal rituals.

Figure 38. Shanghai in 2100 by Luc Schuiten.
It pictures a utopian future in which the city is becoming organic as the buildings, transportation systems and lifestyle are symbiotic

Figure 39. Lilypad Habitat by Vincent Callebaut
This archibiotic concept responds to the challenges of climate, biodiversity, water and health launched by OECD in 2008. It pictures a Symbiotic infrastructure.

Figure 40. Gardens by the Bay Singapore (various firms) and Biodiversity Bridge Netherlands (unknown author) as examples of symbiotic designs

These represent a reflection on what a Bio-culture could be, a vision that can help us define the philosophy of *Symbiotic Design*. The following activity helped the students to make an affirmation of our current state or what our Bio-culture should be, through linking the concept of *Symbiotic Design* itself.

Activity 1. Our Bio-culture

Step 1. Symbiosis reflection

Activity Description: In this last stage, prepare a presentation on the concept of symbiosis illustrating ideas of different types of symbiosis, such as cooperation, commensalism, mutualism and parasitism. The presentation should conclude with a conversation on what kind of creature we are as humans and our creative role. It is recommended that examples of *Symbiotic Design* are included in the presentation.

Narrative Instructions: After learning about the concept of symbiosis and exploring the examples, ask the students: Who are we? What do we want to be? Are we capable of coming together with other species?

Step 2. Imagining our bio-culture

Activity Description: The bio-culture exercise aims to recreate a visual representation of how our worldview changes after learning the eco-techniques and the concept of symbiosis itself. By completing the template 7, the student will discover how his or her worldview can change toward a more ecological and symbiotic way of designing.

Narrative Instructions: On Template 7. Bio-culture (See Appendix E.1) you have three frames that represent the past, the present and the future. In the first frame, you will draw a landscape integrating the curved line which represents a primeval past. Describe the landscape using keywords. The second frame represents our present culture with a straight line. Draw the landscape you perceive and describe it using keywords. The third frame is empty and represents the idea of a symbiotic future. Draw the future you want using your imagination, whilst adding keywords. Finally, the participants will share their drawings with the rest of the group.

After this is completed, an extra activity can be included: ask students to watch a documentary or film with ecological design content in order to compare what kind of ideas have been done, have failed or which we dream of as a human culture (See Appendix E.2).

See the research explorations (6.1.a) on this activity.

b. The metamorphosis of the ecodesigner of the 21st century: Integrating eco-techniques

Humanity may need a metamorphosis of thought and behavior in order to alleviate the crises we face. Through developing an understanding of *Symbiotic Design*, designers can become, guides and connectors triggering changes that would benefit both humans and non-humans in our bio-civilized communities. Now more than ever, we require a metamorphosis that blossoms out of solidarity, mutuality, generosity and spirituality with-in our planet.

As described in the chapter on methodology, the cohesive incorporation of the three fields in design, Biophilia, Biomimicry and Resilience, and the concept of symbiosis itself (here framed as a practice) will help us to reconnect, rediscover and reflect on our role in nature, ultimately to become one with nature. These ecotechniques, named after practiced activities and exercises, provide the foundations from which can enhance the role of the ecological designer of the 21st century, a role that will consequently be that of a mediator of planetary symbiosis.

As explained in the introductory chapter, the individual level is related to biophilia because it exposes the inner need to belong to nature (I); the communitarian level is about non-human relationships working with the intention to create artifice, reflected in biomimicry and its ethic and aesthetic dimensions (it); resilience is the response to complexities and changes caused by human phenomena and natural phenomena into a systemic view of life (Its). When these three levels are recognized, they can connect holistically and fuse together into a single gesture of working 'symbiotically' (we), in order to design with and into a flourishing planet.

The following diagram (Figure 41 below) represents the ecotechniques learned, and the way we can become integral beings of life. The three nested levels combine to create a *Symbiotic Design Practice*, and are based on the four quadrants of integral theory.

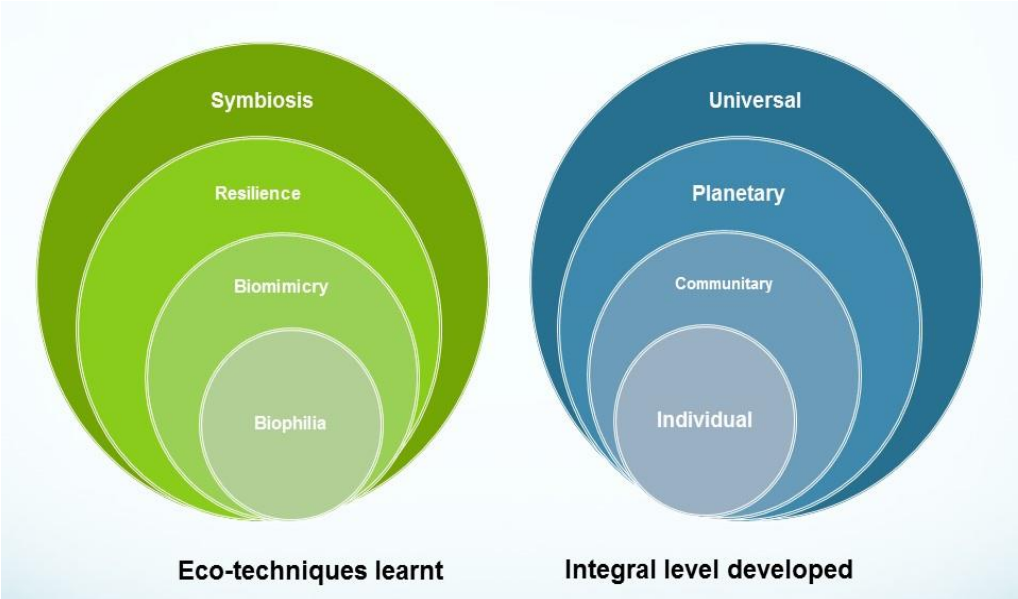


Figure 41. Ecotechniques and the integral levels

In summary, these eco-techniques combine to create the profile of the ecological designer of the 21st century and confirm the idea of *Symbiotic Design* itself. The respective roles of these ecotechniques can be described as follows:

The role of Biophilia: The aim of incorporating biophilia as a preparation stage for design helps to reconnect our individual selves to what we love most, our life and the life of Earth. Being conscious of incorporating ourselves into our natural self, by rewilding our senses and experiencing our true human nature, we can begin the learning journey essential for understanding the set of biophilic values that place ourselves with and against nature. This unlocks mental judgments, frees our bodies and engages our intentions with nature.

The role of Biomimicry: Using biomimicry as a tool provides room to create consciously. It this creative stage, we are able to rediscover true aesthetics following the forms, processes and systemic interrelationships that exist around us. Matching life's patterns through biomimetic designs enable us to act consciously, questioning our capacity to create conditions conducive to life itself. We learn from our fellow organisms to co-design together.

The role of Resilience: Resilience thinking is a forecasting tool that helps us evaluate the impact of design ideas and respond positively to human mistakes and nature's regulatory rhythms. Visualizing systems, considering the future impact of technology and the constant transmission of ancient ecological knowledge as beneficial inheritance, are all reflective features of design.

The role of Symbiosis: 'Becoming with-in the living world', as framed in this chapter, is about symbiosis. This metamorphosing concept helps to realize our role as symbiotic designers. When our design intention is oriented toward the interrelationship of the three key practices, symbiotic consciousness can begin to emerge, and a change of worldview is acknowledged. At this stage, the design becomes truly integral, in both an ethical and aesthetic sense.

These eco-techniques can be used individually to influencedesign methodologies, but when combined, they can enhance the results of regenerative, sustainable, rewilding, biophilic and other types of ecological design expressions. As part of a teaching methodology, these eco-techniques can provide future professional practitioners with solid and formative content for developing ethical, critical and creative skills.

The following activity is aimed at assembling the eco-techniques that the students previously practiced. It also requires an integral evaluation by the teacher, before assessing their final project. This activity helped the students realize that their conventional design worldview had transformed into a more ecological design worldview.

Activity 2. Metamorphosis

Step 1. Review Eco-techniques

Activity description: Incorporating the term symbiosis to conclude the teachings of ecotechniques, and its symbiotic connection, aims to provide the students with a final step toward the achievement of ‘designing with-in nature’, where human intention and nature’s intention converge. Integrating all the concepts (Resilience+Biomimicry+Biophilia+Symbiosis) enables the students to achieve an ultimate goal: transcending as ecological designers or, in other words, symbiotic designers.

Activity Instructions: In a brief presentation, explain the *Symbiotic Design Practice* (SDP) and the integration of its 4 parts: Resilience+Biomimicry+Biophilia+Symbiosis. You can use the SDP process Figure 12 (p.57) and the SDP mandala Figure 9 (p.54) to explain the foundations.

Step 2. Metamorphosis

Activity description: Metamorphosis can be defined as a ‘profound change in form from (one) stage to the next in the life history of an organism’. Transforming our worldview involves going through a process of metamorphosis. Going into the depths of ‘designing with-in nature’ and realizing the individual, social and planetary potential will cause us to develop a sense of purposeful change in the way we design for the Earth. This activity is a way to conclude the series of workshops; it is a self-reflection of the learning journey of the students and the group.

Activity instructions: Using template 8. Metamorphosis (See Appendix E.4) you will guide the students through an origami process of folding and unfolding. Through this process, the student will be able to appreciate what he/she has learned. Drawings, signs, new definitions of design and discussions on their current projects are part of the origami steps. The plain template allows the students to see the intricacy of instructions without revealing the final shape (butterfly) until they conclude all the steps. This can be a form of self-evaluation. When it is folded, it signifies a gift to take home after they conclude their course or workshop(s). At the end of the exercise, students will realise how important it is to become one with nature.

Stage 1. In this first stage, the instruction is related to the concept of biophilia. Draw an animal, plant, bacteria, fungi or ecosystem that symbolizes the idea of a sustainable future. In the same stage, two questions (disclosed at the bottom) relate to the organism drawn, and to how sensitive and open we become when we learn from our eco-others. An individual oral description of the organism drawn, presented to the group, reveals that one's attraction to a special organism or ecosystem is deeply personal.

Stage 2. The instruction is accompanied with a key question related to the module and illustrated with an icon to be chosen that integrates the different ways of defining the course, e.g. design ethics, sustainable development, ecological thinking. A line to define the concept is given and also an option to choose or draw a representative icon.

Stage 3. Step 3 represents an overview of the current projects. The title must be related to their design brief. Here, the working groups must pitch a brief presentation of their final idea. On the line for the specific theme, students will be asked to name the project they are working on and include a description explaining why they want to make that project happen and the project's benefit for society and the planet.

Stage 4. This final step changes the way the student appreciates design or their area of expertise. By summarizing the four concepts – biophilia, biomimicry, resilience and symbiosis – the student will give a new definition of their design concept, and represent it with an icon that symbolizes such a shift.

Stage 5. The instructor continues to give the final steps of folding, narrating the metamorphosis of the template as a representation of the metamorphosis of the student. Such a metaphor is reinforced by finishing up with an origami figure and a short clip, *Papiroflexia* (See Appendix E.2), which represents how important it is to transform ourselves and to see the change we are in the world by *becoming* nature.

See the research explorations **6.1.b** on this activity.

c. The Ecological Journey: Learn to trust the process, not the output

Taking into account the research explorations conducted on the undergraduate module entitled “Design Values, Issues and Ethics”, and other related postgraduate academic activities and events, it appears that the process of becoming a designer through learning from, with and within nature, can be challenging but can also lead to the development of new approaches beyond the traditional design process.

Following development of the methodological framework, the original aim of the module, in which the SDP was developed, focused on aspects of sustainability and ethics through a design project. During the reflective assessments, students emphasized the need to ‘connect with nature’, ‘be the change’ or ‘experience the gardens’. This demonstrates the importace of incorporating ecological thinking in the design academy, which will enable it to become a meaningful discipline for human culture and our planet.

The context in which the students were immersed caused to become aware of the vitality of nature. Ultimately, experiencing these intense emotions enables profound learning to take place (Bonewitz, 1988). The emotions that create a sense of being with-in nature, may stay in our memories forever. The following quotes, extracted from the student feedback questionnaires and reflective pieces, demonstrate how they experienced designing with-in nature:

> *"This module has given me the background and the confidence to question design decisions on their ethical grounds, be it on use of materials or production of waste, cost to the environment or a human cost. Although always being aware of these kinds of issues and challenges, it is often easier not to face them in a design process, or simply to make passive concern, but change little. Avoiding the "great work". So as we all try to face up to our bio responsibility, I feel I now have a relevant perspective from which to begin to question the things we do, as individuals and as designers, to begin a change. One not of great challenges to fear, but one of great expectation on what nature can teach us, when we listen." Student X*

"I really learned a lot about the amazing wealth of creativity of nature. It has definitely made me think more about what I do." Student Y

"Well, at first all the information about how we are destroying our world was rather overwhelming and I wanted to run off and leave this planet, but over time as the weeks progressed I realised that there was something that I could actually do that would make a difference to this world and other people, and as a designer it was not only a privilege to be able to, but something that I was morally responsible for. That I had to, and to not would be the greatest disrespect to my planet and those living on it. I have this opportunity and I must grasp it. This course has given me the tools to do so". Student Z

Outdoor activities which helped students to sense their bodies by sensing nature, including the use of interactive educational material, lectures with a biologist and many other experimental techniques that helped students to prototype and conceptualise planetary ethics, have been discussed throughout this thesis. These were clearly successful in achieving ecological literacy through design.

Guiding the students in an exploration of the true meaning of *Symbiotic Design*, is in essence, a self-realization process. Although some students expressed that they 'did not really know what was the intention of the workshops at the beginning', the activities allowed them to 'feel' that the design – object, service, message or system – is an embodied effect of being alive together with the emotion of the living Earth, in our consciousness and in our hearts. One conclusion, observed through the implementation of these practices, was that when the students started to promote this kind of design, they became more connected with their own selves and started caring about the way they create. Now, as enlivened designers, they are capable of co-creating meaningful experiences in communion with other living beings.

The following activity was presented as the final activity. This is a transcendental representation of an 'ecological learning journey' where the students 'learned to trust a process not the output', through the SDP framework.

Final Activity: Assessing the ecological learning journey

Step 1: The learning journey

Activity description: The following activities are related to a design brief or a challenge to be solved over the period of a module. In terms of evaluation, the fundamental aim of the facilitator is the need to identify how the student:

- Recognizes him/herself as co-creator with nature through design.
- Identifies all the concepts and tools learned during their final project.

In order to build ecological wisdom in the learners, it is necessary to encourage them to tell stories about their personal learning journey which represent their unique and ecological way of seeing the world.

Activity Instructions: One of the formats is to create a story line or personal map of a journey in a written or graphical format which encapsulates their learning experience, explaining how their personal worldview has been changed by learning the eco-techniques (see Appendix E.5 for example).

Step 2: Final assessment

Description: As a way to assess the design student, the facilitator/teacher provided a challenge or design brief to develop over the semester, this was given after the biophilia workshop. At this stage, the project was evaluated and was previously carried out through tutorials in between the series of workshops.

Evaluation of their concept or prototype is conduced through an illustrative reflective writing piece on their design process. It is important to simplify the format thereby allowing it to be communicated and disseminated to the public (an article for a newspaper is a great example). Their final written piece needs to be developed individually and assessed in groups. A group presentation or

exhibition could be an option to present the final design. (See appendix E.6 to see an example of their final assessment).
Step 3: Concluding Survey Description: After the final presentation from the students, it is important to conduct a questionnaire survey in order to allow the students to make constructive comments about the module content and delivery. You can use any software to construct your own questionnaire, such as, Google Docs or Survey Monkey (see appendix E.7 to see example of the final survey).

See the Research Explorations (6.1.c) on this activity.

6.1.2 Becoming with-in nature through the Symbiotic Design Practice

New educational strategies need to consider not only the imperative for facing global challenges, but the necessity in identifying the types of human behavior that cause these challenges; for example, the increase of digital technologies, consumerism and population growth. As discussed in Chapter 1, ecopedagogy in design is able to create the foundations for a holistic way of learning together with-in nature, in order to generate design solutions. The most important feature of the ecopedagogical framework proposed here is to practically integrate symbiotic intention, not just capture it abstractly.

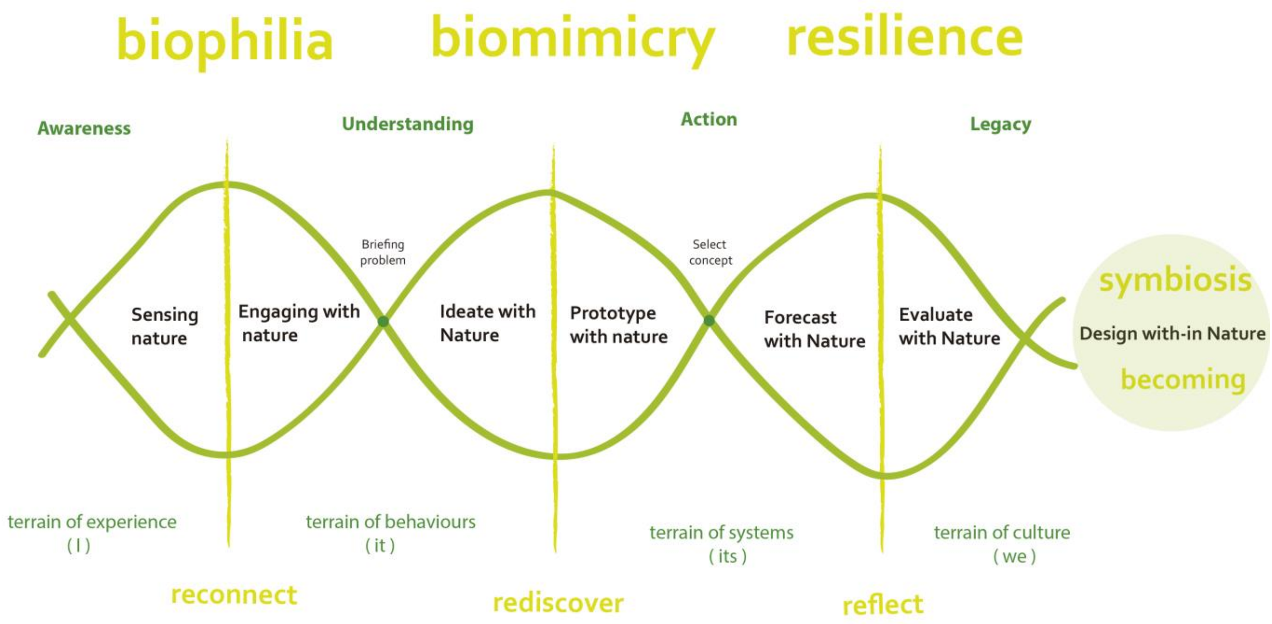
We similarly need to create new narratives through using ecopedagogy.Without a unifying, shared narrative that interprets the past, explains the present and reveals a possible future, education has no purpose (Postman cited inThayer, 2003, p. 233). Expanding on this point, Postman notes that education needs this kind of new narrative:

'The purpose of a narrative is to give meaning to the world, not to describe it scientifically... that it is to provide people with a sense of personal identity, a sense of community life, a basis for moral conduct, explanations of that which cannot be known... Without narrative, life has no meaning, learning has no purpose'.

The positon we are now in has moved beyond the Gods of the Old Testament, the Greeks, the 19th century Naturalists, the Bauhaus School and the complexity of contemporary corporatism of some schools. Perhaps the inherited ideas of contemporary ecologists, such as Arne Naess, E.O Wilson, Thomas Berry, James Lovelock, David Orr, Fritjof Capra and many others from Eastern cultures and indigenous traditions, have begun to shift the paradigm of design education.

Three essential questions are raised in contemporary education: 'Who am I?', 'Where am I?' and 'What am I supposed to do?' (Thayer, 2003, p. 236). The SDP intends to answer the first question: 'who I am?' through biophilic practices, answering: 'I am human and I am a planetary being'. The second question,'where I am?' requires us to place ourselves in the immediate ecosystem community from which 'I am' learning as biomimicry promotes. The third question, 'what am I supposed to do?', can be answered by following nature's patterns, as we reflect through resilience. If we add a fourth question,'Why am I doing it?', this indicates working with symbiotic consciousness,- to design life together to enhance life.

The prime output of learning about symbiosis touches on an integral approach to life. The SDP helps teachers to guide students in achieving the self-realization of becoming one with nature and becoming truly humans. With all the skills acquired (sensing, engaging, ideating, prototyping, forecasting, evaluating with nature and ultimately becoming symbionts), the students are able to create life-enhancing designs, is like the ADN of the ecological designer (see below).



Key Figure . The Symbiotic Design Practice (SDP) process

Learning to love the creation that designers release into the world illustrates that these designers are creating a legacy. Co-creating together is the ultimate wise intention. Our generation is pioneering a legacy concerned with the propagation of love for the service of life itself. With our creativity with and within nature, we have begun to question how these things will transform and nurture our living planet. Sewage systems that generate food, cities that behave like ecosystems and spaces that will be owned and transformed by biodiversity, are just a few examples that can provide a symbiotic design philosophy for healthy innovation for generations to come.

An ecological design culture is developing, and has been permeating our society for the last 50 years. Learning from our human centred mistakes is making us more aware of our primeval and basic needs, and is dismantling greed and ego on many scales. Rewilding, eco-psychology, the Circular Economy and other naturally-inspired solutions are now being taught and are spreading in the collective memory. Ecological Design is part and parcel of this cultural evolution. Nevertheless, there is a lot of work still to be done. Thomas Berry (1998) expressed that the historical mission of our time is to:

- reinvent the human at the species level;
- with critical reflection;
- from within the community of life systems;

- in a time-developmental context;
- by means of story; and
- a shared dream experience.

The ideas discussed by Berry can certainly be achieved through the design curricula. Transmitting this ecological wisdom beyond the arrogant idea of 'leaving a mark in the world' or 'making a difference', we are able to conclude that the *Symbiotic Design Practice* proposed here can continue with a legacy of promoting life meaningfully, through these principles:

- Connect nature's life-supporting strategies in our human centred designs.
- Promote ethics and values into regenerative and co-evolutionary behaviors.
- Establish conscious eco-literate communities.
- Uphold legacy strategies to constantly reframe the notion of bio-culture.
- Search for a symbiotic consciousness, to participate with, change along, and become with nature.

In this context, the *Symbiotic Design* concept aims to generate planetary design ethics, facilitating platforms where the dichotomy of nature/culture co-evolve and interweave so as to provide solutions while progressively making the Earth our home, a home that was inherited and shaped by our non-human ancestors, and which we want future generations to inherit.

In sum, the motivation to leave a legacy for planetary life must be a prime ethical commandment in the formation of ecological designers. Beyond the formation of expertise, the development of an idea, the creation of a new policy, the reconsideration of new values or the acquisition of new skills, is the need to feel alive-in-connectedness. This kind of symbiotic consciousness needs to be transmitted, in one way or another, to be considered inherited ecological wisdom. Our current generation of designers is responsible for developing such a **legacy of 'becoming with-in nature'.**

Chapter 7. General Conclusions

7.1 Designing with-in nature

This thesis argues that generating symbiosis evokes the recognition that the living world made us and that we are capable of creating for the living world. Bringing this philosophy to design has resulted in a transcendental shift, a shift to come together, daring to design beauty, health and happiness for humans and non-humans.

The eco-techniques outlined in this thesis aim to help us to achieve planetary symbiosis. The idea of symbiosis in design calls for an integral ethos of multispecies cooperation, and an activation of our symbiotic consciousness. This kind of reciprocity, or mutually beneficial association, through design is only likely to be achieved if our naturalistic minds and technological minds contain an ecological intention. Our biological tendencies are leading us to recognize biophilic values, biomimetic designs and resilience thinking as intrinsic to new ecopedagogies.

I propose that, as we learn to become symbionts of the Earth, the implementation of ecological designs will increase. Rainwater systems, soil regeneration, the end of waste, the shift to a solar economy, the gentle use of alternative resources and the ethical use of robotic automation are some examples of how technology can be life-enhancing. Acknowledging our mistakes will enable us to live consciously in the present. It will place us in a position in which we will be ready to change our cosmovision (worldview), to rethink our technologies and to be informed by the patterns of nature.

The *Symbiotic Design Practice* (SDP) that I propose is a flexible educational process that promotes the embodiment of practices to perceive the world as it is and become symbionts of the Earth. It seeks to achieve a balance between intuition, natural logic and experiential learning which will then become meaningful and hopeful in design. It is an open invitation to design institutions to provide foundations to co-create with-in nature.

This methodology has been developed for the teacher/facilitator to guide students in acquiring a new worldview with a set of ecological design values that are to be implemented integrally. This worldview is integrated in the *Symbiotic Design Mandala* Figure 9 (p.54).which incorporates symbiosis as a main foundational concept in achieving ecological wisdom and forming a new profile for the ecological designer of the 21st century.

7.1.1 A new ecopedagogy for Design

I propose that the need to interact with a living planet will require the formation of designers as naturalists and technologists, focused on a critical and integral ecological inquiry. In the age of Enlivenment, we are on the verge of this transition. We now know the consequences of anthropogenic-centric design. Reshaping design education into an Earth-centred philosophy is perhaps the most positive and active response to this challenge. As design educators, we can help develop the guidance for this kind of pedagogy.

Some may question whether there is potential for the design academy to incorporate this ecopedagogical framework. I suggest there is! This is an open opportunity to educate students to reconnect, rediscover and reflect with-in the patterns of life. As the sense of purpose and belonging to an animate Earth is reaffirmed in every step, design educators can provide a new ecological way with which to explore the self-realization in maintaining a deep and long-lasting mutual relationship with our planet. As a Gaian strategy, the SDP can be seen as one of many attempts to begin to truly break the current conventions of design education.

Approaching the SDP through design schools, and including it in existing modules in sustainability, ecological design and other related ethical matters, is a way to start. It can also be implemented in extracurricular interdisciplinary workshops and in the planning of undergraduate and postgraduate programmes. I suggest that through this pedagogical practice, the design educator can become a guide in helping to develop critical reflexivity in students as future design professionals. The connected incorporation of these eco-techniques can also serve as a foundational framework for the new schools that are emerging with such ecological philosophies. The facilitation of this co-evolutionary approach also promotes interdisciplinary work with biologists, anthropologists, psychologists and those in other disciplines, moving toward a reconstitution of our Bio-Culture.

This educational framework leads design mentors to continue exploring the paradox of education itself, from knowledge to wisdom. We require ecological wisdom to encourage us to experience the world, not simply to retain knowledge about the world. With ecological wisdom, we are able to understand simpler and more holistic ways of living.

7.1.2 Ecopedagogical Structure

In conducting this research, I have discovered that the *Symbiotic Design Practice* (SDP), as ecopedagogy, is able to provide pragmatic ecological values and ethics to allow designers to refine their design skills and acquire a new lens in which to see the world and design with-in it.

As illustrated throughout this thesis, this is a multi-modal framework which shapes the use of design thinking, deep ecology and integral theory to facilitate four key concepts that will help educators and practitioners shift toward *Symbiotic Design*. The key concepts, biophilia, biomimicry and resilience, presented here as ecotechniques, also represent the new profile of the future designer; the biophilic being, the biomimetic practitioner and the resilient thinker all become one in the symbiotic designer.

Through biophilia, we are able to understand the aesthetics of nature, and recognize ourselves and our minds in nature. In becoming biomimics, we become aware of the patterns of nature and are keen to replicate such aesthetics and to relatedesign to everyday life. With resilience thinking, we are able to follow the language of systems and complexity as collective beings, and are more able to generate new ways of designing the future that we want to leave for our children. Finally, we are able to fully integrate the concept of symbiosis as a new behavioral way of becoming with and within our living world.

This ecopedagogical framework offers an original approach that is different from conventional design methodologies. It incorporates a preparation stage where the individual (student) is immersed in his/her own understanding of nature and creative sense, before starting on a design brief; this is self-realization through biophilia. The second stage is focused on new ways to explore and incorporate the patterns of nature through biomimicry. After designing concepts or prototypes, the student has the opportunity to evaluate proposals in accordance with the principles of life aligned to the process of systems thinking. The culmination of learning about these stages occurs when the student realizes how to become one with the world and to design symbiotically.

The opportunity to test the activities and methods in a formal educational setting was fundamental to the formation of this solid teaching methodology. Seeing how the students involved in the study reframed or reaffirmed their values by experiencing a more appealing teaching environment (the Botanic Gardens and grounds), and by approaching natural phenomena mindfully, confirmed that biophilia is an intuitive tool for designing. Acknowledging that innovation has been happening hand-in-hand with our natural mentors, and by embedding the patterns of nature in their creations, strengthened the view that biomimicry is a practical tool for designing. Incorporating resilience thinking into the activities helped to ethically judge the importance of embracing human creative powers and changing behaviors by learning from past mistakes, acting now and being positive about the future. The idea of 'symbiosis with the living world' as an outcome is, then, a way of affirming the designer's acquisition of ethical and integral ecological skills.

By acquiring these eco-techniques, the designer becomes 'enlivened', realizing how truly capable he/she is of putting into practice what they have learned from the living world. As the designer now perceives nature on an individual level, he/she also becomes aware of the sense of community in nature, and begins to see it in a planetary level. Finally, we all become part of Gaia's animate, poetic and co-operative body. The *Symbiotic Design Practice* is a holistic theory, a pragmatic design method, and a flexible teaching process. In essence, it is a toolkit for achieve ecological design. The explorations, through experimental workshops, literature review and the use of questionnaires as main methodologies, has resulted in the confirmation and validation of this research thesis. This practical Gaian strategy will ultimately be open to debate and will be improved upon as I continue my journey as an educator and design practitioner.

If one of the essential features of our human nature is mutualism, then I propose that this feature should be a key principle of design. Considering ourselves part and parcel of the world, in every creation, is to be symbionts of the world. This notion enhances the essence of ecological design.

The contribution to knowledge with a biophilic, biomimetic and resilient attitudes manifests that *Symbiotic Design* is as a natural design process. By incorporating symbiosis, design educators and design practitioners will be able to reflect life in true organic, biodegradable, protective and serviceable designs (products, services and systems) that are mutually in tune with the needs of this planet.

Instructing designers to be the agents who demonstrate such symbiotic elements will require further investigation of the methods that frame a critical interrelationship between the planetary ethic and aesthetic dynamics. The requirement to dismantle any preconceptions that future designers may have about ecological thought needs to be addressed as part of the academic curricula.

This research, involving a teaching experience with the SDP, revealed that students are capable of developing ecological wisdom as they develop the ability to put themselves in the shoes of non-human organisms and look beyond social needs to see the needs of the planet. The activities tested here were not intended to expand intelligence but to widen its scope to include experiences and acts learned with-in nature. The reseach also enabled me to observe how students critically questioned their own creative capacities by recognizing the dangers and benefits of naturally inspired design, a holistic ability of turning their design ideas into meaningful actions and legacies. As agents of change, ecological designers with a new profile can be critical heralds of innovative change.

Through this stude I also question whether the design academy is capable of transforming and igniting educational trends moving toward a symbiotic culture. As long as the institutions pursue the self-realization of the individual and the collective self, the cosmopolitan-localism, the interdisciplinary connection and, ultimately, the following of natural patterns, education will bring us the wisdom required for the Enlivenment age. The greatest design of nature is all around us, but we have to make it visible and purposeful. Explaining these invisible connections is a means of discovering how *our living Earth* loves and interacts with us.

It is importat that designers get involved with genetic engineering, nanotechnologies, robotics, space exploration or virtual worlds. The shift to find steady states and to recognize human paradoxes will keeping us flowing and sentient with-in Gaia. The *Symbiotic Design Practice*framework presented here can help to prepare us for that shift. This, ultimately, is the philosophy behind this thesis.

The following principles of *Symbiotic Design* have been confirmed through the application of the SDP:

- Implement experiential learning where direct perception of nature is involved.
- Seek spaces to contemplate and sense the body in context.
- Engage with the wonder and mystery of Nature.
- Encounter a more-than-human world before starting to solve any design challenge.
- Consider the natural history of the design and its evolutionary dynamic.
- Follow the patterns of nature (forms, functions, systems and processes) through its interconnections, rhythms and cycles.
- Allow living organisms to inform ideas and solutions for your immediate needs.
- Use an interdisciplinary lens to design.
- Design considering the local and global context.
- Perceive meta-systems and interconnections in forecasting. Any bio-inspired technology will create consequences; a sense of resilience is needed.
- Frugality, gentle action and descent scenarios are ways to develop resilient and ethical designs.
- Evaluating a design project in terms of when it 'makes sense' for life on earth, right here right now.
- *Symbiotic Design* considers mutualism and co-evolution with the web of life.
- *Symbiotic Design* considers human and non-human interactions.

- Achieving a *Symbiotic Design* means becoming part of the world and being in service with our human gifts.

These are some of the contributions that the SDP promotes:

A biocultural transition.
As mentioned in the introduction, if we use biomimicry alone as a method, the design may become parasitic. If we use a combination of biophilic practices and biomimicry, the process becomes a mutualistic strategy. If resilience thinking is used alone without experiencing and following the intuitive part of biophilia, then the method becomes ineffective and anthropocentric interactions can take place. Connecting these three concepts into one can help us to move toward a 'bio-cultural' transition urgently required for the well-being of human and non-human societies.

The revolution in design education.
We can shift from ecological knowledge to ecological wisdom, an action that should be implemented at all levels of education and in all disciplines. This shifts the paradox, from narrow-mindedness to a holistic way of teaching design. By incorporating the SDP, the design academy should be able to build ethical values, strengthen creative practices and provide critical views on decision-making about technology, but most importantly, it will be able to develop an integral worldview by acquiring a symbiotic consciousness.

The new profile of the designer.
The *Symbiotic Design* skills are aimed at facilitating an interdisciplinary dialogue, providing a holistic/systemic perspective for questioning human paradigms informed by natural patterns and promoting the pragmatism here in the present with allavailable resources. As an educator, it seeks ecological wisdom and provides the students with a critical inquiry on intentionality. As a biophilic being, a biomimetic practitioner and a resilient thinker, the designer becomes proficient in creating objects, buildings, systems, communications or services which reframe worldviews and provide a meaningful and hopeful heritage.

What can the design academy (lecturers, researchers) do with this? For a design educator, these strategies may present an appealing image for the design schools of the 21st century, where our recognizable ecopedagogical frameworks *promote life* itself. Establish programmes, modules and the formation of design communities will help to consciously bring about a fundamental basis for promoting a flowing change within nature and the limits of technology, thereby crafting a meaningful human presence on planet Earth.

This should ignite a vital consciousness, encouraging design professionals and academic practitioners to 'design with and within nature'. The more conscious we become of the revelations that biodiversity embeds within our symbiotic consciousness, the healthier our society will be. Biophilic cities, biomimetic objects, metabolic services and ecosystemic interactivities can all be part of a new language in a design bio-culture for the 21st century.

7.2 Further steps and dissemination

- One aspect that was identified in this research was the need to engage young students with these topics. One of the next steps is to compile a 'short version' of this thesis and create a booklet to be embedded in the curricula for higher education, and perhaps adapt other versions for kindergarten and K-12 education. This could also be used in companies and other related organizations who wish to pursue eco-literacy or want to develop ecological design. As a creative toolkit, the format will include texts, activities, audio-visuals, games and the SDP rationale.

- As the main contents are biophilia, biomimicry and resilience, I plan to establish alliances with other networks interested in these topics to collaborate on interdisciplinary projects. The formation of collaborative groups focused on the SDP topics has just begun. Biomimicry UK was established as a social enterprise which started to run workshops, giving lectures and providing consultancy in architectural, product design and organizational projects. Co-operation with the European Biomimicry Alliance has also been instigated. Related events and institutions have embraced the methodology, for example, of Global Sustainability Jam 2013, Hablo Diseño 2014 (conference in Mexico) and the Dundee Science Festival 2014. There is also an upcoming plan to develop a Biomimicry Summer School in 2017 with Schumacher College and other higher education institutions in Europe, Mexico and the US.

- I also plan to incorporate the philosophy of *Symbiotic Design* in the creation of an ecological maker lab or into an alternative design school, in which ecological design thinking and making is integrated at its core.

- I have begun to use/teach this SDP at postgraduate level in the MA in Ecological Design Thinking at Schumacher College, where it was well received. Here, I discovered that this framework is by its nature very flexible and can be implemented in a short course, a semester and maybe integrated in a full master's degree.

- From this ecopedagogy, I intend to establish my own design studio and offer consultancy for ecological design projects, education intuitions and the creation of community-led projects.

- This methodology is a proposal that can be extended by integrating more eco-techniques or even substituting the terms with synonyms or ecological-derived terminologies.

- Awards and Papers: A Highly Commended Honorary Graduates' Award for Innovative teaching was given during this research process in 2014, by University of Dundee, CASE (College of Art, Science and Engineering). The award is presented to academics who demonstrate an effective teaching philosophy linking teaching and research to enhance the undergraduate design curriculum. The certificate is shown in Appendix A.2. Three papers have also been published and they are shown in Appendix A.1.

Epilogue

My interest in design began 15 years ago in the form of an exploration of my own creative capabilities. I was completely unaware of the ecological ethics of being a designer, and my teachers taught nothing about ethical inquiry. When I became a Master's student and then subsequently an academic, I knew I had a mission. I realized how important it is to act and think in accordance with the patterns of nature. After all these years of research, I know how to be in service *with-in* nature. This forms a purposeful gift that I want to continue giving to design students, as well as inspire the design academy and, ultimately, the wider world.

If future generations are to be responsible for transforming our culture into a Bio-culture, we need to consider the types of learning spaces and settings which facilitate mindful exploration and thoughtful discovery. What kind of mentors will be guiding them? What kind of ecological values will they be creating through design? These are some of the questions that I will continue to explore, and remain vigilant about as an academic.

Is it possible that we designers can see ourselves as creative participants with the living world? I believe that we can choose to fulfill the needs of a human and non-human world, through a symbiotic way of designing. The activities practiced through the eco-techniques help to guide students to apply their best skills toward the development of a healthy and beautiful biosphere.

There is a fable that illustrates the intention of this research:

> ***The bird and the forest in flames***
> *When the fire started in the forest the animals began to flee from the consuming flames. However, one little bird made use of his flying skills and collected water in his beak to pour on the flames. The rest of the animals were amazed but the fire kept advancing and the bird didn't stop. The rest of the animals realized the effort this little bird was making and that the bird's action alone would not douse the flames. They all joined in and began to help in their own ways to quell the fire.* (Source unknown)

The message here is that each of us, as designers or educators, can 'do our part' not only influencing but acting in response to what nature is telling us. The proposed design methodology and ecopedagogical framework is a practical ecosophy that supports the theoretical portfolio of PhD studies from the Centre for the Study of Natural Design in Dundee. It is, perhaps, a small seed that may take years to germinate.

This research has given me so much satisfaction that I now want to:

- Give guidance to students to self-realize who they want to be as designers, and most importantly to be inhabitants of the Earth.
- Give education institutions alternative strategies to facilitate ways of moving toward a bio-civilization.
- Strengthen curricula and courses through embedding consciousness which is symbiotic with our planet.
- Be of service to communities that need and want to incorporate ecological design.

I cherish a hope that my generation will be responsible for exchanging the idea of a civilized world for a bio-civilized world. As designers, we become morally responsible for connecting the metaphor of nature with the question of desired human utopias. As educators, the quest for wisdom will be strengthened by helping students to encounter our symbiotic consciousness with the Earth.

Biomimicry and biophilia are revealing non-human intelligence and conscious interaction with-in nature. Resilience thinking is bringing a sense of coherence in responding to ever-emergent descending and accelerating scenarios. Implementing these concepts as design practices can facilitate sensible, intuitive and ultimately mindful ways of connecting skilled minds toward a symbiotic consciousness, where human intentions and non-human intentions converge. These *bio-synergistic practices,* acquired by the students and therefore *inherited* by the academy, are my general contributions on how to <u>educate with and within nature</u> through design.

My ecosophy of design embraces and respects life right here, right now, as a participant in this micro-cosmos. Let's feel life, let's be curious about life, let's wonder, let's give thanks for the gifts we are able to provide, let's be inviting, let's dance with the spiralling rhythms of nature, let's keep making interconnections, let's give the free love all deserve, let's promote healthy regenerative nurturing, let's keep making design with meaning... let's be fully human.

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Glossary

Assumptions of nature as culture by Eder (1996)

1. 'The relationship of humanity to nature is becoming disenchanted. Nature is being superseded by a man-made nature which appears as a threatening world that determines the ordinary life of people.
2. The area of nature that is accessible to human action is expanding. An increasingly mutual dependence of humanity and nature is arising.
3. The knowledge of nature is monopolized in the scientific system. People are becoming increasingly dependent on the specialist who reproduces social knowledge of nature'.

Contributions to the Ecopedagogy movement by Kahn (2010)

- Provide opening for the radicalization and proliferation of Ecoliteracy programs both within schools and society
- Create liberatory opportunities for building alliances of praxis between scholars and the public on ecopedagogical interests.
- Foment critical dialogue and self-reflective solidarity across the multitude of groups that make up the educational left during an extraordinary time of extremely dangerous planetary crisis.

Khan also identifies that an ecopedagogical researcher will thus 'think about the ways in which different cultures know and interact with nature's order generally, always to side with and begin from peoples' standpoints-from-below in terms of discursively exploring what (along with where, when, how, and why) it is these groups know' (Kahn, 2010, p. 112). Another fact is that ecopedagogy can help us not only to enhance our ecoliteracy but also our technoliteracy. Khan reiterates a positive emergence of planetary techno-ecology (Kahn, 2010, pp. 61–62). Within this concept, we can identify that design plays an active role in the development of our contemporary technopoly to overcome the technophobic/technophilic responses in a dialectical critical design theory and praxis. In this case, the reconstitution of education implies multiple literacies.

Cultural Evolution Patterns by Michael Greer (2009)

1. Cyclical patterns: Rhythms that rise and fall, and are present in the history of civilizations as well as in natural ecosystems. This allows a degree of prediction when human society expands beyond the limits of its environments. Time scale: centuries.
2. Succession patterns: A process that replaces R-selected social forms with a series of K-selected forms, where the climax community remains stable until changes in the environment disrupt it. Always subject to change. Time scale: millennia
3. Evolutionary patterns: Cultural evolution that gradually accumulates useful techniques and leverages, by way of some previously unused resource base, into a sudden leap into a new form of human ecology. It branches outward along whatever lines for advance may be available. Time scale: lifespan of human species.

Current Challenges we face as society by Baumaister (2013)

- The current political and economic climate globally, causing many to rely on old paradigms ("but they worked before…");
- The tendency of humans to focus on short-term feedback loops (which evolutionarily make sense, and worked well for us when our ability to impact the world was limited);
- The growing divide between the amount of time we spend in nature and time we spend with technology; and
- Our current focus on certain leverage points in humans systems that, while more "manageable", have relatively limited impact (e.g. the focus on metrics) as compared to those that are more challenging (e.g. paradigm shifts) but far more impactful.

Deep ecological premises by Arne Naess (in Sessions, 1995)

- The well-being and flourishing of human and non-human life on Earth has intrinsic value.
- Richness and diversity of life forms contribute to the realization that these values are values in themselves.
- Humans have no right to reduce this richness and diversity to satisfy vital needs.
- The flourishing of human life and culture is compatible with a substantial decrease of human population. The flourishing of non-human life requires such a decrease.
- Present human interference with the non-human world is excessive and the situation is rapidly worsening.

- Policies must therefore be changed. These policies affect basic economic, technological and ideological structures. The resulting state of affairs will be deeply different from the present.
- The ideological change is mainly that of appreciating life quality (dwelling on the situation of intrinsic values) rather than adhering to an increasingly higher standard of living.
- Those who subscribe to the foregoing points have an obligation, directly or indirectly, to try to implement the necessary change.

Ecological Design explanations by Orr (2004)

- Ecological design is not simply a more efficient way to accommodate desires; it is the improvement of desire and all of those things that affect what we desire.
- Ecological design is as much about politics and power as it is about ecology. We have good reason to question the large-scale plans to remodel the planet that range from genetic engineering to attempts to re-engineer the carbon cycle. Should a few be permitted to redesign the fabric of life on the earth?
- Ecological design is not so much an individual art practiced by individual designers as it is an ongoing negotiation between a community and the ecology of particular places.
- Ecological design is neither efficiency nor productivity but health, beginning with that of the soil and extending upward through plants, animals, and people. It is impossible to impair health at any level without affecting it at other levels. The etymology of the word "health" reveals its connection to other words such as healing, wholeness, and holy.
- Ecological design is an art by which we aim to restore and maintain the wholeness of the entire fabric of life increasingly fragmented by specialization, scientific reductionism, and bureaucratic division. We now have armies of specialists studying bits and pieces of the whole as if these were separable. In reality, it is impossible to disconnect the threads that bind us into larger wholes up to that one great community of the ecosphere. The environment outside us is also inside us. We are connected to more things in more ways than we can ever count or comprehend.
- The act of designing ecologically begins with the awareness that we can never entirely fathom those connections. This means that humans must act cautiously and with a sense of our fallibility.
- Ecological design is not reducible to a set of technical skills. It is anchored in the faith that the world is not random but purposeful and stitched together from top to bottom by a common set of rules. It is grounded in the belief that we are part of the larger order of

things and that we have an ancient obligation to act harmoniously within those larger patterns.

- Ecological design grows from the awareness that we do not live by bread alone and that the effort to build a sustainable world must begin by designing one that first nourishes the human spirit.
- The goal of ecological design is not a journey to some utopian destiny, but is rather more like a homecoming. In other words, we are lost and must now find our way home again.
- Ecological design is to reflect for all of our technological accomplishments; the twentieth century was the most brutal and destructive era in our short history. In the century ahead we must chart a different course that leads to restoration, healing, and wholeness.
- Ecological design is a kind of navigation aid to help us find our bearings again. And getting home means recasting the human presence in the world in a way that honours ecology, evolution, human dignity, spirit, and the human need for roots and connection.
- Ecological design is a community process that aims to increase local resilience by building connections between people, between people and the ecology of their places, and between people and their history.
- Ecological design takes time seriously by placing limits on the velocity of materials, transportation, money, and information.
- Ecological design eliminates the concept of waste and transforms our relationship to the material world.
- Ecological design at all levels has to do with system structure, not the rates of change. The focus of ecological design is on systems and "patterns that connect." When we get the structure right, "the desired result will occur more or less automatically without further human intervention."

Ecozoic Era determining features by Thomas Berry (1998)

The concept was coined by eco-theologian Thomas Berry while in extended conversation with Brian Swimme in the late 1980s. The term Ecozoic encompasses the ideas of space-time-human-Earth relations. According to Berry, it asks: 'How shall we live? and How shall we live so that others may live?' It is a perennial idea deeply embedded in what it means to be human, expressed in the cultures, customs, religions, myths, and facts of the developmental story of the human family. It has roots that reach deep into the mysterious development of our human body and our human psyche (Berry, 2011). Here some of the determining features:

- 'Earth is a communion of subjects not a collection of objects.

- Earth exists and can survive only in its integral functioning. It cannot survive in fragments any more than any organism can survive in fragments. Yet, Earth is not a global sameness. It is a differentiated unity and must be sustained in the integrity and inter-relations of its many bio-regional modes of expression.
- The entire pattern of the functioning of Earth is altered in a transition from the Cenozoic to the Ecozoic Era. The major developments of the Cenozoic took place entirely apart from any human intervention. In the Ecozoic, the human will have a comprehensive influence on almost everything that happens.
- A new role exists for both science and technology in the Ecozoic period. Science must provide a more integral understanding of the functioning of Earth, and how human activity and Earth activity can be mutually enhancing. Our biological sciences especially need to develop a "feel for the organism", a greater sense of the ultimate subjectivities present in the various living beings of Earth. Our human technologies must become more coherent with the technologies of the natural world.
- New ethical principles must emerge which recognize the absolute evils of biocide and geocide as well as the other evils concerned more directly with the human.
- New religious sensitivities are needed that will recognize the sacred dimension of Earth and that will accept the natural world as the primary manifestation of the divine.
- A new language, an Ecozoic language is needed. Our Cenozoic language is radically inadequate. A new dictionary should be compiled with new definitions of existing words and an introduction of new words for the new mode of being and functioning that are emerging.
- Psychologically all the archetypes of the collective unconscious attain a new validity and a new pattern of functioning, especially in our understanding of the symbols of the tree of life, the heroic journey, death and rebirth, the mandala, and the Great Mother.
- New developments can be expected in ritual, in all the arts, and in literature.
- Mitigation of the present ruinous situation, the recycling of materials, the diminishment of consumption, the healing of damaged ecosystems – all this will be in vain if we do these things to make the present industrial systems acceptable. They must all be done, but in order to build a new order of things.'

Enlivenment Epoch principles by Weber (2013)

The idea of 'Enlivenment' thought was seeded by biologist Andreas Weber who examines that, by acknowledging antagonistic ways of being, we are capable of recognizing the cooperative aspect of life, just as symbiosis. His stance is to reflect on the idea or dualism of what we consider anthropocentric and bio-centric, artificial and natural, technological and primitive, ordered and chaotic, narrow and open, life-death; such ideas are then reflected back on the idea of feeling 'alive'. He identifies how 'embracing a non-dualistic viewpoint allows for more inclusion and cooperation because there is no disjuncture between 'rational theory' and social practice; the two are intertwined.' Weber suggests that this term is an upgrade of the deficient categories of Enlightenment thought – a way to move beyond our modern metaphysics of dead matter and acknowledge the deeply creative processes embodied in all living organisms. Weber also compares the latest work of E.O Wilson who expresses the need for a 'New Enlightenment Era'.

Enlivenment tries to supplement – not to substitute – rational thinking and empirical observation – the core practices of the Enlightenment position – with the 'empirical subjectivity' of living beings, and with the 'poetic objectivity' of meaningful experiences. He explains that in order to transcend such poetics into the practical realm it is fundamental to avoid conflicting terms that focus on dead matter and conflicting meanings such as survivalism - including the term 'sustainability' - by embracing a new cultural orientation toward the open-ended, embodied, meaning-generating, paradoxical and inclusive processes of life.

Weber discusses how the Enlightenment ideology brought about not only freedom, but also some of the great totalitarian-technocratic catastrophes of the 20th century. This tradition of thought is responsible for the current unsustainability of our planetary ecosystem. It reflects profound errors of understanding about human thought (epistemology), relationships (ontology) and biological functioning. The idea of Enlivenment is meant as a corrective. It seeks to expand our view of what human beings are as embodied subjects. This notion, Weber explains, does not exclude the role of human rationality and agency, but it does connect them with other modes of being, such as our psychological and metabolic relationships with the 'more-than-human' world, in both its animated and non-animated aspects. Enlivenment links rationality with subjectivity and sentience.

He also describes that this idea of being with Nature is "much more like ourselves than we might imagine: It is creative and pulsing with life in every cell. It is creating individual autonomy and freedom by its very engagement with constraints. On an experiential level, as living creatures on this animate earth, we can understand or "feel" nature's forces if only because we are made of them.

The Enlivenment worldview can explain the world only in the 'third person', 'as if everything is finally a non-living thing, denies the existence of the very actors who set forth this view. It is a worldview that deliberately ignores the fact that we are subjective, feeling humans – members of an animal species whose living metabolisms are in constant material exchange with the world' (Weber, 2013, p. 29).

Weber distinguishes that Enlivenment is not an arcane historical or philosophical matter but a set of deep ordering principles for how we perceive, think and act. If we can grasp enlivenment as a vision, we can begin to train ourselves to see differently and approach political struggles and policy with a new perspective. He deduces how the political consequences of adopting such an approach, which he calls "policies of enlivenment," are far-reaching. The idea of Enlivenment, as Weber explains, does not specify explicit outcomes or norms for how an enlivened society should be conceived. Rather, it is concerned with the overarching principles and attitudes that can foster the emergence of open, mutual, and cooperative processes. The following principles extracted from his essay reflect how we are shifting toward it:

- 'Natural history should no longer be viewed as the unfolding of an organic machine, but rather as the natural history of freedom, autonomy and agency.
- Reality is alive: It is full of subjective experience and feeling; subjective experience and feeling are the prerequisites of any rationality.
- The biosphere consists of a material and meaningful interrelation of selves. Embodied selves come into being only through others: The biosphere critically depends on cooperation and 'interbeing' – the idea that a self is not possible in isolation and frenetic struggle of all against all, but is from the very beginning dependent on the other – in the form of food, shelter, mates and parents, communication partners. Self is only self-through-other. In human development this is very clear, as the infant must be seen and positively valued by its caretakers to be able to grow a healthy self. The biosphere is not cooperative in a simple, straight-forward way, but paradoxically cooperative: **Symbiotic relationships** emerge out of antagonistic, incompatible processes: matter/form, genetic code/soma, individual ego/other. Incompatibility is needed to achieve life in the first place, and therefore any living existence can only be precarious and preliminary – an improvized creative solution for the moment. Existence comes into being through transitory negotiations of several incompatible layers of life. In this sense, living systems are always a self-contradictory 'meshwork of selfless selves'.

- The individual can only exist if the whole exists and the whole can only exist if individuals are allowed to exist.
- The experience of being alive, of being in full life, of being joyful, is a fundamental component of reality: the desire for experience and to become one's own full self is a general rule of 'biological worldmaking' which consists of both interior/experiential and exterior/material construction of a self.
- Death is a reality. Death is inevitable and even necessary as the precondition for the individual's striving to keep intact and to grow. Death is an integral component of life (we should talk, rather, of Death/Life when referring to organic reality.) Against this background, enlivenment is what an organism constantly does: every organic act is an act of creation, be it unequivocally productive or 'stuck' as disease with its symptoms.
- The living process is open. Although there are general rules for maintaining embodied identity in interbeing, its form and way is entirely subject to situational solutions. Also, in this respect the creative processes of the biosphere have creative and enlivening parallels in the arts.
- There is no neutral, trans-historical information, no general 'scientific' objectivity. There is only a common experiential level of understanding, interbeing and communion of a shared 'conditio vitae'. New structures and levels of enlivenment can be made possible through enacted imagination'.

Weber concludes that with these observations it seems possible 'to complete the highly limited 'mainstream' ecological worldview that now prevails (nature viewed as an exterior pool of resources) with an interior or intentional aspect.'

Features that the Biomimicry as practice must integrate by Baumasiter (2013)

1. "More interdisciplinarity. This entails translating cultures and languages as well as understanding how interrelationships with other disciplines can contribute to the practice of biomimicry."

2. "Access to biological information. Databases that display the strategies used and the biological information built by universities, research labs and field stations around the world. This also includes places to foster naturalists."

3. "Time to deepen the practice. Projects and prototypes could take years to develop. When we discover an organism and want to develop new designs or

when we need to redesign an artefact or process, we must find the time to explore in more depth."

4. "Better storytelling. The new media captures disruptive innovations. As the biomimetic design becomes part of our lives, we must keep in mind the way biomimics tell stories and how the message is ethically delivered."

Five Ecoliterate Practices by the Centre of Ecoliteracy (n.d)

1. **Developing Empathy for All Forms of Life** encourages students to expand their sense of compassion to other forms of life. By shifting from our society's dominant mindset (which considers humans to be separate from and superior to the rest of life on Earth) to a view that recognizes humans as being members of the web of life, students broaden their care and concern to include a more inclusive network of relationships.
2. **Embracing Sustainability as a Community Practice** emerges from knowing that organisms do not exist in isolation. The quality of the web of relationships within any living community determines its collective ability to survive and thrive. By learning about the wondrous ways that plants, animals, and other living things are interdependent, students are inspired to consider the role of interconnectedness within their communities and see the value in strengthening those relationships by thinking and acting cooperatively.
3. **Making the Invisible Visible** assists students in recognizing the myriad effects of human behavior on other people and the environment. The impacts of human behavior have expanded exponentially in time, space, and magnitude, making the results difficult if not impossible to understand fully. Using tools to help make the invisible visible reveals the far-reaching implications of human behavior and enables us to act in more life-affirming ways.
4. **Anticipating Unintended Consequences** is a twofold challenge of predicting the potential implications of our behaviors as best we can, while at the same time accepting that we cannot foresee all possible cause-and-effect associations. Assuming that the ultimate goal is to improve the quality of life, students can adopt systems thinking and the "precautionary principle" as guidelines for cultivating a way of living that defends rather than destroys the web of life. Second, we build resiliency by supporting the capacity of natural and social communities to rebound from unintended consequences.
5. **Understanding How Nature Sustains Life** is imperative for students to cultivate a society that takes into account future generations and other forms of life. Nature has successfully supported life on Earth for billions of years. Therefore, by examining the

Earth's processes, we learn strategies that are applicable to designing human endeavours.

Teaching ecological literacy also involves the following:

- Weaving ecological and systems approaches into the existing curriculum in a coherent way that builds student knowledge over time. (Note: The focus should be on ecological concepts and their relationships to each other – both the big picture and the details – and to the active preservation of the ecosphere rather than incremental inclusion of ecological concepts.)
- Building teacher capacity in the areas of ecology and systems thinking,
- Learning from nature through immersion in the real world (nature and communities) and a deep knowledge of particular places,
- Acknowledgement of place-based and experiential outdoor learning as essential to the cognitive development, health and well-being of children,
- Cultivation of a sense of wonder, creativity and compassion for nature and for community,
- Transformation of the school into a living laboratory of buildings and processes that teach children about their interconnectedness to nature and their communities, and
- Linkages to Higher Education resources and schools that allow students to continue the development of their Ecological Literacy.

These points, which are directed to K-12 levels of education, can also serve as a basis for the formation of any area of design.

Five perceptual practices by Laura Seawall (1995)

1. 'Learning to Attend: Focused attention produces a richness of color, a depth of sensory experience and often means the difference between seeing or not seeing. The ability to fully use our attentional capacity is a learned skill, requiring the practice of mindfulness and awareness.'
2. 'Perceiving Relations: We are interested in identifying, naming and obtaining objects. We reduce wholes and systems into component parts. We are not particularly adept at perceiving the interface between media and forces, context, or processes and we rarely 'read signs' that the world itself is telling us in her patterns. We must value our subjective and sensual responses.'
3. 'Perceptual Flexibility: Requires a fluidity of mind in which the magic of the visible world is revealed by relinquishing one's expectations and nurturing a freshness of vision, it is

seeing formal patterns within apparent chaos, rearranging pieces and allowing new images to emerge. Pattern and metaphor are revealed.'

4. 'Perceiving Depth: This concerns changing worldviews. It involves talking to ourselves and allowing a sensual response that comes from a recognition of being within, held by a Gaian Interpretation. An embodiment that liberates us, a spirited form of communication, a communion with a non-human world, as the sensual experience of being within something magnificent and much vaster than ourselves.'
5. 'The Imaginal Self: The practice of visual imaginery that shows us the power of our worldview to determine perception, and ultimately reality. We can invent our worldview, imagine our future as a guide to determine desires and act accordingly.'

Goethean Method Steps By Harding (2009)

1. *'Intuitive perception* – This step involves encountering a phenomenon without preconceptions through active looking.
2. *Exact sensing* – This step involves careful and precise examination of parts (shapes, colors, patterns), suspending any urge to theorize.
3. *Exact sensorial fantasy* – This step involves merging ourselves with the phenomenon in time and using our imagination to vary what has been seen.
4. *Seeing in beholding* – This step is when a revelation of the phenomenon is given to inner being, a holistic quality.
5. *Being one with* - This final step involves returning to our intuitive precognition, a manifestation of a single immanent loving creative energy' (p. 41).

Futures Methods Features (various authors)

1. Forecasting

While science fiction has been inspiring human invention, such fiction must also illustrate the failures of not acting in the present and with real interactions. The ecological revolution and its techniques must influence ways of acting in the present, among our real living planet, responding to the future naturally.

Forecasting is to cure our short-sightedness by embracing change but also by going back to review and re-learn, and redesign past technologies and life-styles. New technologies become hidden, used by very few or simply becoming 'just an option' within a whole spectrum of options. For example, the phenomenon occurring with the Internet in terms of using different platforms of social media, collaborative apps and databases, will make us pay attention to the constant change and need to experience something new, and then back to old ways of authentic tangible interaction. We have the gift of intuition to see the possibilities.

Schumacher (1988, p. 190) defined that 'forecasts are offered which upon inspection turn out to be conditional sentences, or in other words, exploratory calculations'. Schumacher also identified that the future is largely predictable, if we have solid and extensive knowledge of the past. Largely, but by no means wholly; for into the making of the future there enters that mysterious and irrepressible factor called human freedom. Schumacher writes: 'It is the freedom of a being of which it has been said that it was made in the image of God the Creator: the freedom of creativity'. He adds that if there is no element of freedom, choice, human creativity and responsibility, everything would be perfectly predictable, subject only to accidental and temporary limitations of knowledge (ibid p. 191). When we do not use that freedom, we can respond to a given situation that does not alter greatly in time, unless there are overpowering new causes. Schumacher distinguishes that:

- 'Full predictability (in principle) exists only in the absence of human freedom e.g. in sub-human nature. Limitations are purely of knowledge and technique.
- Relative predictability exists with the regard to the behavior pattern of very large numbers of people doing normal things (routine).
- Relatively full predictability exists with regard to human actions being controlled by a plan which eliminates freedom e.g. railway timetable'.

For Schumacher, forecasting techniques can be identified as short-term forecasts (which can be informed by judgment), plans (which are directed by a statement of intention) and long-term forecasts (when seen as presumptuous and absurd, unless it is obvious) (ibid, pp. 193–200). These remarks suggest that whatever we design, within our free will already lies the idea of a future. Certainly computers, models, thinking in systems and prototypes are all machines that can help us to foretell the future, but ultimately we, as creatives, are the ones who design the good and bad questions.

2. Backcasting

If forecasting is the process of predicting the future based on current trend analysis, backcasting approaches the challenge of discussing the future from the opposite direction (Wikipedia, 2015). Backcasting is often more effective than forecasting, which tends to produce a more limited range of options, hence stifling creativity (The Natural Step, n.d.). Recently, ideas of low-tech, soft-energy paths, permaculture or post-industrial design involve the development of backcasting scenarios, almost as defuturing. This implies the representations of the world after crisis or peak oil scenarios. Holmgren (2009) proposes the need to descend to a steady state of the planet to recover our levels of resilience. Backcast innovations have been covering our basic needs that can help us to understand what we really need now, in the present. Acting in the present to cover basic needs will be easier, because we learn how to do it. On the other hand, future casting of such basic needs, and its innovations, is probably the most crucial part because we still need to let future generations recognize and define their needs as they evolve through time. Acting in the present, but bringing skills from the past and thinking positively about the future, can help us to reduce the incremental change so as not to surpass the thresholds or boundaries that our generation is living within.

3. Trend analysis

Trend analysis is a way of studying the future by examining current trends to predict the direction and intensity of changes in the future. Cramond concludes that one prediction that came true, and will undoubtedly be true again, is the successful adaptation to world change and that the continued civilization of our world depends on creative endeavours (*Encyclopedia of creativity.*, 2011, pp. 423–25).

According to the Copenhagen Institute of Future Studies (CIFS, 2006), megatrends are the great forces in societal development and will very likely affect the future across all areas over the next 10-15 years. This way of using trend analysis to forecast is embraced by lots of companies and organizations as a strategic tool. The CIFS describes megatrends as the forces that define our present and future worlds, and the interaction between them is as important as each individual megatrend. Such probable futures are used to develop scenarios and starting points to analyze the world we live in. Although such scenarios are not certain, they are still used to react and to be prepared. CIFS describes that futures researchers always work with three types of futures: the predictable, the possible, and the preferred. They also describe how these trends can change direction as a "wildcard" - events that are unlikely, but that would have enormous consequences – slowing a megatrend's development or create counter-forces. Such unexpected events, such as September 11, can temporarily slow actions. Although for most of the experts megatrends are certainties, they always contain elements of uncertainty or wildcards described. They also can contain paradoxes or in other words counter-forces, such as the transition movement or circular economy early mentioned.

With this overview on megatrends, we can identify that trend analysis sometimes requires statistical and other related computation techniques. But if analyzed qualitatively it can be easy to work with. With trend analysis we can identify linearity, curves, cycles or patterns. However, trend analysis is not capable of prophecy. Instead it sharpens our judgment and quickens our understanding of elements to create the future (Kurtzman, 1984, pp. 74–89).Teaching trend studies can be used as a methodology to ignite resilience. In this research it is discussed as tool for activating a sense of the right innovation processes.

4. Scenarios and System Modelling

Future search methods are sometimes based on systems interrelationships, which implies the necessity to map the harmony between sub-systems so as to achieve larger systems goals. It also implies the reflection of values; either personal or collective, which requires investigating on behaviors via systems thinking (Kurtzman, 1984, pp. 22–26). Cycles and rhythms embedded in a system and the planning of human endeavours can help us to forecast. For example, socio-economic depressions can help us to understand patterns which could be repeated not accurately, but with a trend. Like the heartbeat, economic crash goes up and down. Our living planet has a rhythm of seasons, our bodies follow patterns of development, the ecosystem will decay and grow again, and many other examples represent that thinking back and forth is important.
In relation to scenarios and testing models, Meadows (2008, pp. 189–90) suggest sthat:

- System dynamic models explore possible futures and ask "what if" questions,

- Model utility depends, not on whether its driving scenarios are realistic (since no one can know that for sure), but on whether it responds with a realistic pattern of behavior.

The Scenarios method (Hanington and Martin, 2012, p. 152) in design is another helpful tool to communicate a visual or descriptive narrative of the cultural artefacts present in day-to-day life. By mapping out complex problems in a systemic fashion, designers put into action not only the systemic way of thinking but visioning the effects of a given design. The designer's flexible ways of thinking can easily identify such systemic drivers. Teaching the student to design with complexity enhances their capacity to respond to drastic changes; recovering from unexpected events such as natural disasters, but also from technological disturbances, is a matter of forecasting with nature.

5. Future Scenarios

Future scenarios is a method for telling a story about the future, relying upon the real facts of today for their background and logic, the interactions of a system for their driving force and the most probable facts of tomorrow for their outcome (Kurtzman, 1984, pp. 45–9). Fry (2008, pp. 147–148) briefly defines it as a methodological tool of designing from the future to the present and it requires skill and practice. It is not 'what will be' or even 'what might be' but 'what potentialities beg interrogation; this is for possible precautionary design responses. The process proceeds by dialogical steps: starting by establishing a view of what, in the present, is a future determinant; then using this knowledge to elaborate a future. Fry identifies two implications: Impact events, factored in the notion of a continually modified present, and Relational events, traced as triggers of change in other spheres of exchange. It implies the act of designing from the narrative of a moment in time and then back from that moment; in doing so, we can make the decision in the future redundant or expose them as inappropriate and dependent upon chronological, geographical and situational parameters. The only criterion is that they have to work. The more detail between events the better. It extends the role of the designer even further. Fry also identified that a scenario creation needs to be configured by:

- A coherent change agenda. What is desired to be changed from/to with the scenario being the means to articulate change.

- Structuring of modes of cooperation. Dynamics of group working begs design.
- Use of a deconstructive methodology able to undercut unexamined foundations of thought.
- Rigorous understanding of the problems that prompt the scenario and identification of human and non-human change agents that the scenario would require for its realization.

This method relies upon a good degree of creativity, intuition and insight which in turn relies on logic, history and observed fact. Kurtzman (ibid) proposes some key questions regarding this method: What is the purpose of the scenario, what is the relevant data? What is the main theme of the scenario? How did the main facts interact? What is the present situation? What is the most probable scenario? These questions can be used to build the story.

6. Visioning and Delphi Method

Visioning is a method of imagining, at first general and then with increasing specificity, what you really want. Vision without action is useless, action without vision does not know where to go or why to go there. Vision is absolutely necessary to guide and motivate action. Vision when widely shared and kept firmly insight, brings into being new systems. There is a need to build a preferred, shared vision. On the other hand, the Delphi method is a highly structured method for polling experts on their considerations and opinions regarding some aspect of the future. It attempts to get a 'consensus' of expert opinion on the issue under consideration (Kurtzman, 1984, p. 63).

Hannover principles by Braungart and McDonough (2009)

- Insist on the rights of humanity and nature to co-exist
- Recognize interdependence.
- Respect relationships between spirit and matter.
- Accept responsibility for the consequences of design
- Create safe objects of long-term value.
- Eliminate the concept of waste.
- Rely on natural energy flows.
- Understand the limitations of design.
- Seek constant improvement by the sharing of knowledge.

Holistic curriculum features by Miller (2007)

- 'Linear thinking and intuition. To find a balance using metaphor and visualization to integrate traditional thinking approaches.
- Between mind and body. To sense the connection between the two. Movement, dance and drama can be explored.
- Among domains of knowledge. To connect academic disciplines and school subjects. E.g. Waldorf schools use the arts to learn about the world.
- Between self and community. To go from the classroom to the global community. The student must develop interpersonal, community service and social action skills.
- Relationship with the Earth. To listen to the voice of the Earth; sounds of animals, wind and rippling streams can connect us with the web of life.
- With the self and soul. The holistic curriculum lets us realize our deeper sense of self, our soul. Our true nature' (ibid. pp. 13–14).

Miller also proposes 5 principles regarding the earth-connections and holistic education

- All education must be part of an inclusive context as we need to connect with everything as its ultimate reference point, which is the universe itself. Anything less is simply not education.
- Education should be a mastery of one's person not a mastery of a subject matter
- Knowledge carries with it a responsibility to use it.
- That knowledge must be looked at from an inclusive context and how it impacts on communities.
- We need authentic examples.
- How we learn is as important as what we learn.

By incorporating holistic thinking we must be aware of the following steps

- Uncertainty/Ambiguity: Be aware of unsolved situations and be ready to help to clarify and explore problems.
- Frameworking: In order to see the problem from a broader perspective it is necessary to define an outline of the way we are going to approach and evaluate the problems
- Incubation: Let the exploration and the problemsolving process happen without much restriction while meditating, walking or driving.
- Alternative search: As we dive consciously into our search, let the other courses of action happen. Link the framework to give a bit of focus following a sequence of research

- Illumination: Settling on the course of action, the assessment is linked with an intuitive insight but also the criteria. Let the student be creative and unlock its inflexibility as it might be reworked.
- Verification: As the solution is now tested, is it worth questioning if it's worth it or needs to search for other solutions? Realizing that small sections are unclear is positive.

How an ecomind thinks? by Lappe (2013)

- 'Less about quantities and more about qualities;
- Less about fixed things and more about the ever-changing relationships that form them;
- Less about limits and more about alignment;
- Less about what and more about why;
- Less about loss and more about possibility.'

Johannes Itten body exercises

'Movement of the arms and legs, by bending and turning the whole body, with special regard to the mobility of the spinal column.

1. By standing, sitting, or reclining, keeping the body perfectly still, and relaxing one part after another through concentration i.e. relaxing the organs.
2. The use of sound vibrations. Producing sounds to feel where the body is vibrating. Using an intense hummed note to feel the power of the heart'.

Mindful Design Practice Framework: A Brief Overview by Andrahennadi (2013)

The Mindful Design Practice Framework was developed and integrated within the *Masters for Service Design* programme at the University of Dundee, Scotland as a part of the PhD research study conducted by Kumanga Andrahennadi MA.

Introduction:

The Mindful Design Practice Framework is designed to cultivate a deeper understanding of the inner-designer, and is based on the Buddhist core teachings of the *Four Noble Truths* and the *Four Establishments of Mindfulness.* The Mindful Design Practice Framework can help the *inner-designer* to become a mindful design practitioner through cultivating a deeper understanding of the Self, by recognising and understanding the *Four Noble Truths*: truth of the suffering, truth of the origin of the suffering, truth of cessation and the truth of the path.

Mindfulness or *Sati* (in the Pali language) is the heart of Buddha's teachings, as Thich Nhat Hanh (1998) points out. The *Satipatthāna Sutta* (the discourse on the establishing of mindfulness) and the *Mahāsatipaṭṭhāna Sutta* (the great discourse on the establishing of mindfulness) are two of the most important and widely studied discourses, and includes the *Four Establishments of Mindfulness.* The mindfulness of body (*kāya* in *Pali*), feelings (*vedanā* in *Pali*), mind (*citta* in *Pali*) and phenomena (*dhamma* in *Pali* or mental events); have the similar aim to help in the recognition of the nature of mind. These discourses confirm that there are six modalities of consciousness, which correspond to the five sense organs; eye, nose, tongue, body and the mind as sixth, as well to the five sense objects; forms, sounds, smells, tastes, touches with thoughts as the sixth.

Mindful Design Practice Framework includes the aspects of the mindfulness of mind and phenomena, which refers to the six modalities of consciousness as mentioned above. The water element has been introduced as the object of establishment of mindfulness with the six sensory bases; seeing, hearing, smelling, tasting, touching and the mind as the sixth.

The Practice:

The Mindful Design Practice Framework consists of three stages known as the waterfall, river and the ocean. Within the Buddhist teachings, the intense activity of the mind is compared to a waterfall continuously pouring over a cliff, as the thoughts flow continuously. Eventually, the experience will vary from following the thoughts to focusing on the practice, and this is known as the river. As the practice continues, the inner-designer will be able to maintain the awareness and focus almost continuously with few distractions, like the ocean without waves. Any disturbance in the surface of the ocean, like a wave, will gradually settle back to the ocean itself. Finally, the inner-designer will be able to experience the calm ocean without wind, and can meditate for as long as he/she wants without distraction. Subtle thoughts do not interfere with the practice or the focus, thus becoming a stable practice with the inner-designer's ability to rest the mind at will. The Mindful Design Practice Framework has also incorporated elements of the Mindfulness Based Stress Reduction/Cognitive Therapy frameworks and is also supported by interviews and dialogues with eminent Buddhist teachers such as H.H. the 17th Karmapa, V.V. Mingyur Rinpoche and V.V. Ringu Tulku Rinpoche.

Mindful Design Practice Framework:

Stage 1: Practices aimed at recognising the 'Waterfall'

Session 1: Seeing (Venue – MA Service Design class room, University of Dundee)

9:30 am – 11.00 am: Practice on 'Forms of Water' focused on the sense of 'Seeing' including an introduction to mindfulness, the body scan practice and dialogue.

Session 2: Hearing (Venue – MA Service Design class room, University of Dundee)

9:30 am – 11.00 am: Practice on 'Smells of Water' focused on the sense of 'Smell' including the mindfulness of breathing, whole body experience and a dialogue.

Stage 2: Practices aimed at recognising the 'River'

Session 3: Smelling (Venue – MA Service Design class room, DJCAD)

9:30 am – 11.00 am: Practice on 'Sounds of Water' focused on the sense of 'Hearing' including the mindful movement practice and a dialogue.

Session 4: Tasting (Venue – MA Service Design class room, University of Dundee)

9:30 am – 11.00 am: Practice on 'Tastes of Water' focused on the sense of 'Tasting' including the three step breathing space practice and a dialogue.

Stage 3: Practices aimed at recognising the 'Ocean'

Session 5: Touching (Venue – MA Service Design class room, University of Dundee)

9:30 am – 11.00 am: Practice on 'Touches of Water' focused on the sense of 'Touch' including being present with difficulty practice and a dialogue.

Session 6: Mind (Venue - Botanical Gardens, University of Dundee)

1:00 pm – 2.30 pm: Practice on 'Thoughts of Water' focused on the sense of 'Mind' including the mindful walking practice, kind awareness practice and a dialogue.

Session 7: Six senses retreat 1 (Venue - Botanical Gardens, University of Dundee)

3.00 pm – 5.00 pm: Creative practices on 'Water' focused on all the senses including the rainbow meditation and mountain meditation, mindful walking practice, mindful movement practice and the loving kindness practice and a dialogue.

Session 8: Six senses retreat 2 (Tentsmuir beach, Angus)

10:30 pm – 12.30 pm: Creative practices on 'Water' focused on all the senses including mindful walking practice, mindful movement practice, the loving kindness practice, the water ceremony and a dialogue.

Statement from Hazel White, Head of MA Design Services, University of Dundee:

"As part of the Design for Services Programme at the University of Dundee we ran a four-week Mindful Design Practice module (MDP). Mindfulness practice is a way of rebalancing thoughts and reducing anxiety through meditation practice, which we feel frees our students minds up to be creative in new and challenging situations. Our masters programme is an intensive one year of study, many students are juggling the responsibilities of family, part-time work or adapting to a new culture and language: a heady mix which does not always foster creativity. The mindfulness practice complements the design research and practice element of the module - supporting students as they gather insights from a range of people in new and sometimes challenging environments. The mindfulness practice is led by practitioner Kumanga Andrahennadi in six ninety-minute sessions in the design studio at the university and two short (two hour) 'retreats' to the Botanic Gardens in Dundee and a local beach. In the sessions the participants were guided through a series of exercises to reduce the number of thoughts in their mind. Feedback from the students (which will be published within Kumanga Andrahennadi's PhD thesis and the short documentary film) suggested that the mindfulness practice gave them 'space' for their thoughts and many of them reported on the positive impact it had on keeping them 'balanced' throughout their study."

Nature as Model, Measure and Mentor principles by Benyus (2002)

- **Nature as model**. Studying nature's models and then imitating or taking inspiration from these designs and processes to solve human problems (e.g. a solar cell inspired by a leaf).
- **Nature as measure.** Using an ecological standard to judge the "rightness" of our innovations. After 3.8 billion years of evolution, nature has learned: What works. What is appropriate. What lasts.
- **Nature as mentor.** Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but on what we can learn from it.

Principles of a system by Meadows (2008)

- A system is more than the sum of its parts.
- Many of the interconnections in systems operate through the flow of information.
- The least obvious part of the system, its function or purpose, is often the most crucial determinant of the system's behavior.
- System structure is the source of system behaviors. System behavior revels itself as a series of events over time.

Principles of ecoliteracy by Centre for Ecoliteracy (n.d)

- Head (Cognitive): Approach issues and situations from a systems perspective. Understand fundamental ecological principles. Think critically, solve problems creatively, and apply knowledge to new situations. Assess the impacts and ethical effects of human technologies and actions. Envision the long-term consequences of decisions
- Heart (Emotional): Feel concern, empathy, and respect for other people and living things. See from and appreciate multiple perspectives; work with and value others with different backgrounds, motivations, and intentions. Commit to equity, justice, inclusivity, and respect for all people
- Hands (Active). Create and use tools, objects, and procedures required by sustainable communities. Turn convictions into practical and effective action, and apply ecological knowledge to the practice of ecological design. Assess and adjust uses of energy and resources
- Spirit (Connectional). Experience wonder and awe toward nature. Revere the Earth and all living things. Feel a strong bond with and deep appreciation of place. Feel kinship with the natural world and invoke that feeling in others

Principles of symbiosis by Kisho Kurokawa (1997)

Kurokawa differentiates symbiosis within three different aspects related to social humanism:

1. Coexistence describes a relationship regardless of what problems or differences the entities have.
2. Harmony is where the differences that do exist are coordinated in balance.
3. Compromise is a moratorium to share a common ground and without any particular intention.

The following points also helped to underpin his definition of symbiosis:

- 'It encompasses opposition and contradiction, and refers to the new, creative relationships born from competition and tension.
- It refers to a positive relationship in which the participants attempt to understand each other despite mutual oppositions.
- It denotes relationships that spark a level of creativity impossible for either party to achieve alone.
- It refers to relationships in which the participants try to broaden their shared ground, while respecting individuality and cultural differences.
- It positions one's own existence within the larger biological scheme of giving-and-receiving.'

In the section of his book Man and Nature, Kurokawa depicts how we are entering an ever-changing process of 'transmigration', into an ephemeral way of life (p.233). Japanese houses have key features, such as, wood, tatami mats, paper walls, openness, outdoor sounds, hedges. He expresses that accepting an eventual degeneration and collapse of the construction is acceptable because it is part of the rhythm of nature. He contrasts such descriptions with the western traditions of construction, using thick walls and narrow windows and the ideas of separation and domestication of nature, like the gardens of Versailles Palace or American lawns. He mentions the 'borrowing from nature' philosophy present in eastern traditions.

From a resilience thinking perspective, we can recognize how Kurokawa addresses the issue of disaster prevention, whereby miniature forests, watercourses, and artificial islands can help to stop flooding, minimize damage from earthquakes, provide easy evacuation, stop fires, and can be used as refuges and stabilize physiological effects. The concern with the landscape we 'lend' and the one we 'borrow' is also present in such regard. Indeed, when we remove, overexploit or fail to respect the sacred zones, then we will experience the consequences. He also recognizes that man-made lakes, canals and forests, and even our cities and our technology, are part of nature. He insist that such dualism makes us nature, and the idea that what human beings have produced is opposed to nature, should no longer hold.

The issues of technology, especially in reference to the issues of health and medical implants, is also addressed by Kurokawa. For instance, being sick can also be considered as experiencing oneself as living in symbiosis (i.e. co-existing with the disease, to heal or to die). In this respect, we need to be aware of the fact that we exist to sustain life, and enjoy it as it goes on. Kurokawa distinguishes that the philosophy of symbiosis offers the acceptance of 'a co-existence between life and death' (p. 281).

Resilience comparison in a community By Hopkins (2008)

Non-Added Resilience	Adding Resilience
Centralized recycling	Local Composting (decentralized)
Ornamental tree plantings	Productive tree plantings
Sourcing organic food internationally	Local production supporting emerging industries
Imported 'green building materials'	Specifying local building materials (cob, hemp, etc.)
Low-energy buildings	Local 'Pasiv Haus'
Ethical investment	Local currencies
Consumerism	Reciprocity

Resilient Design Principles by Resilient Design Institute (n.d)

1. Resilience transcends scales.
2. Resilient systems provide for basic human needs.
3. Diverse and redundant systems are inherently more resilient.
4. Simple, passive, and flexible systems are more resilient.
5. Durability strengthens resilience.
6. Locally available, renewable, or reclaimed resources are more resilient.
7. Resilience anticipates interruptions and a dynamic future.
8. Find and promote resilience in nature.
9. Social equity and community contribute to resilience.
10. Resilience is not absolute.

Resilience thinking steps by Salt and Walker (2006)

1. Systems perspective. Understanding that we are part of linked system of humans and nature (social-ecological system), which is complex and adaptive.
2. Understanding thresholds and adaptive cycles. Social-ecological systems can exist in more than one kind of stable state. If a system changes too much it crosses a threshold and begins behaving in a different way, with different feedbacks between its component parts and a different structure. It's undergone a 'regime shift.' Changing overtime is systems dynamics. Conceiving that systems move through four phases, rapid growth, conservation, release and reorganization (not always in that sequence) is important in understanding a cycle. These adaptive cycles operate over many different scales of time and space.

3. Apply resilience in an understanding of the real world. For example where to put it into operation or its implications in policy and management are part of a valuable insight of this approach. Resilience systems are more open to multiple uses while being more forgiving for management mistakes.

Resilient Organization principles by Wolley-Barker (2016)

- Build around a unified purpose.
- Implement simple rules with coordinated communication.
- Facilitate self-repair cascade mechanisms.
- Let emerge.

Roots of Ecology by Hayward (1995)

Ecology grew from a complex interaction of natural history and physiology. Linnaeus, for example, discussed the *oeconomy* of nature referring to God's setting up of an enduring community of peaceful coexistence that for its time was holistic. Following this, Ernst Haeckel provided a Darwinian definition: 'as a field of the study of the *economy of nature*, the mutual relations of all the organisms which live in a single location, their adaptation to the environment around them, the transformations produced by their struggle for existence.' Contemporary ecology and physics are now converging toward a metaphysical consensus. Ranging from ancient knowledge philosophies to the grassroots of *Oikos*, we still need emancipation in order to change.

Six recommendations for 'Earth Systems Governance and Stewardship' by Young and Steffen (2009)

1. 'Draw on multiple types and sources of knowledge.
2. Pay attention to long-term consequences.
3. Learn how to cope with uncertainty.
4. Create sensitive monitoring systems
5. Emphasize social learning as well as adaptation management.
6. Prepare for crises as periods of opportunity.'

Six guiding principles of *Jugaad* by Radjou et al (2012)

1. Seek opportunity in adversity.
2. Do more with less.
3. Think and act flexibly.
4. Keep it simple.
5. Include the margin.
6. Follow your heart'.

Socratic Approach by Stenberg (n.d)

- How to use the show-rather-than-tell approach to balance competing interests in everyday decision-making tasks,
- How to incorporate one's moral and ethical values into one's thought processes,
- How to think dialogically (other-centred approach to understand multiple viewpoints)
- How to think dialectically (to understand a solution that is right at one time and places may be wrong when circumstances change) and,
- How to become self-conscious in a positive and enlightening way, monitoring one's own thought processes and decisions through a lens of wisdom.

Sustainability to Resilience Key aspects By Walker and Salt (2006)

- 'The key to sustainability lies in enhancing the resilience of social-ecological systems, not in optimizing isolated components of the system.
- To ignore or resist change is to increase our vulnerability and forego emerging opportunities.
- Any proposal for sustainable development that does not explicitly acknowledge a system's resilience is simply not going to keep delivering the goods.
- Sustainability focuses in creating efficiency and optimization within the elements of complex system for humans and nature but the more we intend to create efficient optimal states the more we diminish systems' resilience.
- Current approaches to sustainable natural resource management are failing us, because too often they are modelled on the average condition and expectations of incremental growth, ignore major disturbances and seek for optimization of isolated components.
- While increasing efficiency is important for economic viability, when undertaking this without considering the bigger system and changes to unrecognized benefit, the responses will not lead to sustainability; they can only lead to economic collapse'.

Symbiotic Consciousness Principles by Kelly (2014)

1. 'A foundational paradigm of life, depictive of life's collaborative and connective force of existence.
2. An inherent condition and behavior of integral awareness in all living beings (networks).
3. A basic pattern of self-replicating, incorporative response seen through increasing scales of complexity (patterns).
4. An exchange of consciousness through the sharing of information and material (communication).
5. A process that creates the network of being and relations, structured by a framework of exchange (form/structure).
6. Patterns of self-recognition emerge to create complex structure of cooperation (collective/colony)'.

The island project by Seaton et al. (2007)

The *Island Project* reported on an exploratory interdisciplinary assessment to evolve a hypothetical sustainable island society over a period of 450 years. The objectives were to measure whether, and how, two separate groups of students might conceive a new society over a long timescale, based upon principles from social and deep ecology, holistic science and design, and to observe if aspects of a new worldview emerged during the experiment. A Goethean/phenomenological approach was used in the observation of two scale models of islands (based upon actual Azorean islands) and in the development of conceptual narratives. The two teams were drawn from diverse nationalities and areas of expertize. At the end of the project, the two teams had developed approaches to collaboration, development of social and cultural systems, pragmatic, sketching and presentation methods. The project concluded with recommendations for future developments of the *'Island Project'* and its potential value to other disciplines and trans-disciplinary learning events' (Baxter et al., 2007).

The symbiotic man idea by De Rosnay (2000)

De Rosnay describes that entering into a new age of symbiosis and co-evolution will bring a new set of values. His proposal of such a symbiotic humanistic morality involves:

- Cooperation and solidarity between nations, omnipresent control, partial loss of individualism and the monitoring of cybernetic mechanisms will be regulated and spirituality reintegrated. Politics, religion and sciences will converge.

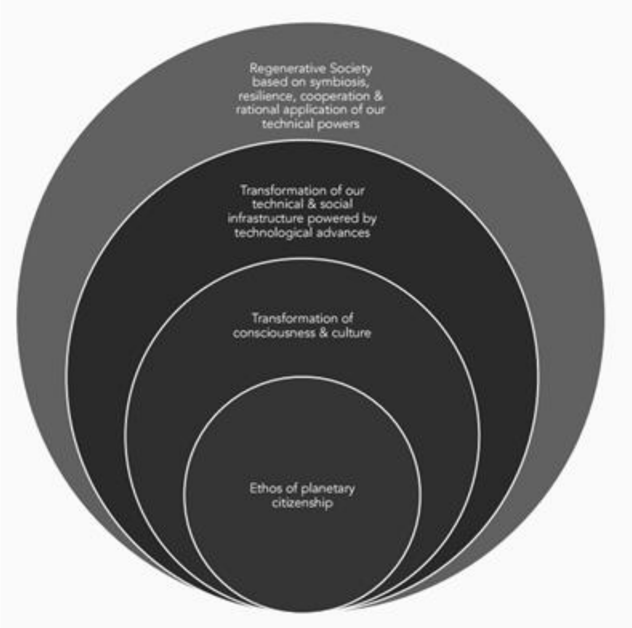
- Time will be questioned in order to harmonize different spheres of time whereby different forms of life, different societies and macrolife will be defined by their density in time, and possibly with other forms of life in other galaxies.

He also describes how such symbiosis is the 5th paradigm:

- Copernican - a step out from geocentrism.
- Cartesian - an emphasis on the power of analysis and logic to master Nature.
- Darwinian - a movement back into nature, an exit from anthropocentrism.
- Systemic - a holistic perspective that gives humanity back its role in the universe.
- Symbionomic - an emergent unified approach in which individual and collective action are joined together in a coherent whole, including arts and technologies, nature and artifice, culture and civilization.

Toward regenerative society by CPC (2014)

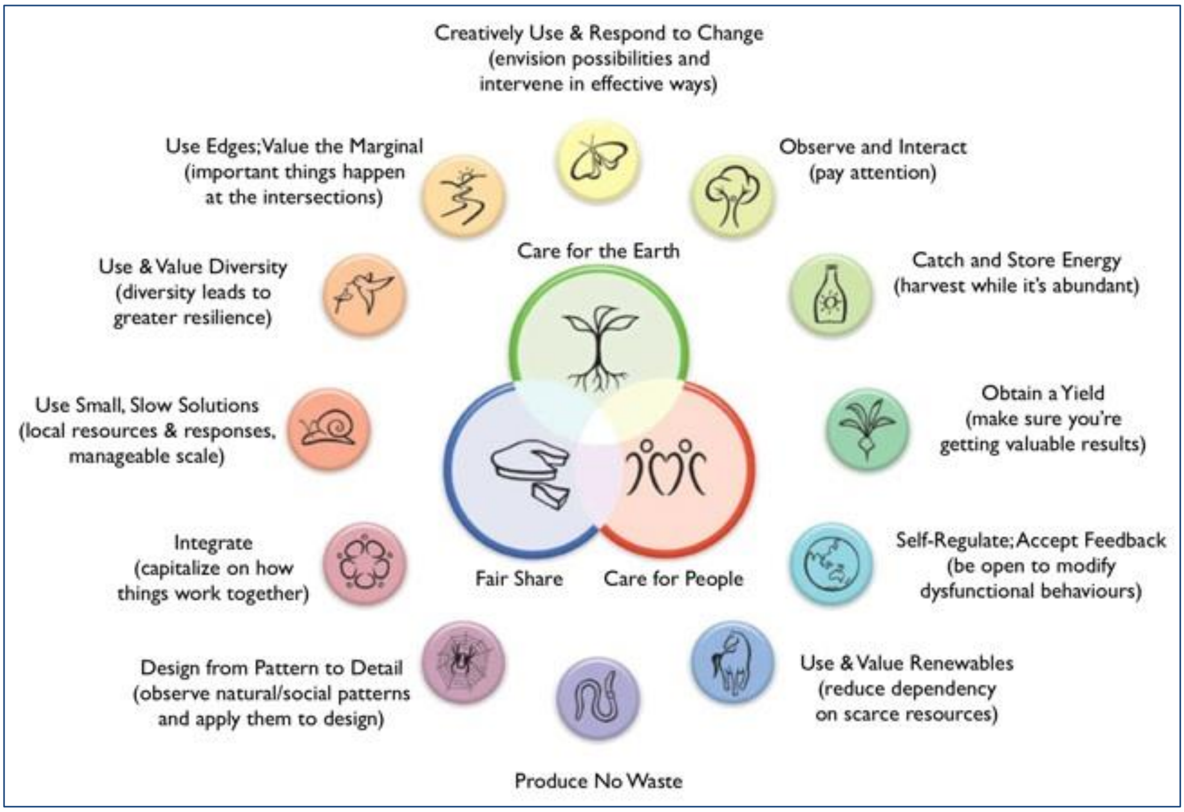
The Centre for Planetary Culture outlines the elements of a 'regenerative culture', and a rapid path to attaining it. This centre outlines that, for the sake of future generations, we can become part of a wave of awakening and of action that grows exponentially, and that under this extreme time pressure, there is great potential to quickly develop and distribute a new social model based on an ethos of global citizenship and planetary stewardship (Center for Planetary Culture, 2014). The organization concludes that for this to happen, humanity must act upon our unique capacity for self-awareness and foresight. And finally that we must collectively work to envision a new model for planetary civilization, then design and manifest it



Towards a Regenerative Culture (CRC, 2014)

The nested diagram shows that, to achieve a regenerative society, we need to go to the ethical core.

12 Permaculture principles by Holmgren (2010)



Research Explorations and Appendices

Research explorations

Contents

Biophilia

(3.1.a) -Activity 1. Our natural classroom....367

(3.1.b) -Activity 2. Sensing....370

(3.1.c) - Activity 3. Bio-meditation....372

(3.1.d) -Activity 4. Movement....373

(3.2.a) -Activity 5. Seeing....375

(3.2.b) -Activity 6. Lensing....377

(3.2.c) - Activity 7. Wondering....378

Biomimicry

(4.1.c) -Activity 1. Bio-inspired stories....379

(4.1.d) -Activity 2. Recognizing the Principles of Life 380

(4.1.e) -Activity 3. Focusing....381

(4.2.a) -Activity 4**.** Rediscovering....383

(4.2.b) -Activity 5. Prototyping....385

Resilience

(5.1.b) -Activity 1. Thinking Resilience....386

(5.1.c) -Activity 2. The Resilient Island....387

(5.1.d) -Activity 3. Forecasting/Backcasting....390

(5.2.c) -Activity 4. Evaluating Resilience....391

Symbiosis

(6.1.a) -Activity 1.Our Bio-culture....392

(6.1.b) -Activity 2. Metamorphosis....394

(6.1.c) -Final Activity: Assessing the ecological learning journey....396

Biophilia

Research Explorations (3.1.a) -Activity 1. Our natural classroom
Observations by the researcher: • The pilot workshop was conducted mainly in the design studio at DJCAD. The session on Biophilia was only a one-day session at the Dundee Botanic Gardens (see the Appendix B.2. for details of the space). The students and facilitators' experience was very enjoyable, with a good response noted in the questionnaire conducted at the end of the module (see Appendix. B.3). For this reason, in the second year and third year iterations, all the sessions were fully taught at the Dundee Botanic Gardens educational facilities. This action produced amazing results in the development of the activities and fulfilment on the learning journey of the students. • This location was also considered for the related outdoor activities incorporated into the workshops on Biomimicry and Resilience (to be discussed in the following chapters). Thus, it is recommended that this first step be conducted as a full course or module in a location with a similar 'immersive' characteristics. • The Biophilia workshop requires one full day,but it could be divided into two or three sessions, depending on the time available. • One of the fundamental theories to cover in this step, apart from Biophilia definitions and Gaia theory, is the clear explanation of biophilic values (Kellert and Speth, 2009, p. 27) (see Appendix. B.4 for the typology of biophilic values description). Design students will be able to identify these principles as ethical facts which describe the emotional, physical, intellectual and moral development of individuals as biophilic beings. • The way in which their capabilities flow without any bias, and acknowledging that they are learning biophilic values, reconciles their worldview and enables them to accept that 'being ecological' is not a trend but a <u>self-interested virtue</u>. • The audio-visual biophilia activity was developed, in the first explorations, within a series of clips after the short lectures about biophilia. It was not until the formal exploratory workshop that the videos and remembrances of

students' favourite organisms were implemented as a way to uncover personal affiliation with nature. Sharing memories of biophilic experiences, from a young age, is key at this stage.

Feedback and reflections from students:

- By learning about Gaia Theory, learners developed a new worldview. In the qualitative evaluations conducted after the biophilia sessions, the students' responses showed how engaged with nature they became.
- Providing the students with a schedule or agenda for the day was very helpful in promoting curiosity and maintaining interest in the sessions. Students frequently refered to the schedule, which served as a guide throughout the session (For a sample of the agenda, see Appendix B.5).

Lessons learned:

- Lectures on site can be used to consciously establish the an egaging link between humans and what we call nature; this then makes it easier to approach the experiential exercises students practice in outdoors spaces.
- Biophilia theory equips the learner with a new ecological vocabulary.
- The *sensing nature* stage of the SDP can be interpreted as an instructional process of experiential learning, in which the mix of structured lectures and outdoor activities are methods used to reconnect with nature. The natural classroom stimulates emotion, intuition and self-realization as part of their formation as designers.
- Stimulative activities were analyzed through interlinked events that the researcher experienced before starting this research, mainly on a field trip conducted at a natural reserve in South Mexico.. These experiences were reinforced during the first year of this research through an exercise of 'sensing nature' in part of a week-long course for Biomimicry Educators conducted by the Biomimicry Institute in Findhorn College, Scotland, and by including them in the set of the experimental teaching workshops at the Dundee Botanic Gardens.
- Through this study, this researcher observed that, in being exposed to a retreat-like space, the students were able to:
  - Experience something new
  - Explore and feel freedom

- Expect to learn in a different way
- Be ready for the unexpected

Figure 42. Students at the Dundee Botanic Garden facilities

Research Explorations (3.1.b) -Activity 2. Sensing

Observations by the researcher:

- In the pilot workshop, the activities worked very well; these involved the use of the Dundee Botanic Gardens grounds, previous activities learned at the biomimicry workshop for educators and the teachings by the researcher at Los Tuxtlas, Mexico. It was not until the participation in a Mindful Design Practice workshop with PhD scholar Kumanga Andrahennadi that the tasting step was introduced and some of the sensing steps were refined. These reflective exercises involving the senses are a way to support a conversational activity about sense of place, and enable development of further steps on mindful meditation (See activity 3).

Feedback and reflections from students:

- The blindfold was the most successful activity, following by the sensory part. For some of them, the trust and responsibility of helping others who were blindfolded was clearly a good experience, as was expressed in conversations. They felt transported to another world, their senses become more attuned and they became 'less scared about nature', as one student noted.

Lessons learned:

- The sense of seeing was not included, not only because it is the main human sense that we use as designers, but because it will be fully explored in a further exercise using the Goethean Method of Observation, and will be used to conclude with the biophilic practices.
- These first stimulative exercises used to activate our Biophilia – feeling, smelling, hearing, tasting and walking in the place that we are learning or designing – are considered the preparation step for designing.
- These sensing exercises need to be introduced at the beginning of a workshop or course. They will help to clear the students' minds and allow them to become more sensitive when approaching any topic, as discussed by Andrahennadi (2014). They also complement other meditational exercises.

- In the reflective exercise, students can discuss or expand upon the use of biophilic values and the use of metaphors or explanations regarding how other animals use their senses.
- These activities uncover how our senses are adapted to a bigger whole. This also takes us back to our primeval biology or natural history to find that we are shaped by the place we inhabit.
- These activities are key to clearing our senses, starting to reading nature's patterns and feeling our emotions, which is fundamental to design.

Figure 43. Students doing sensing activities

Research Explorations (3.1.c) - Activity 3. Bio-meditation

Observations by the researcher:

- This meditation exercise was introduced during the final research study within the Mindful Design Practice (MPD) module, led by PhD scholar Kumanga Andrahennadi in 2014, where the researcher was a participant. Since then, the researcher has continued with this particular practice and has introduced it into his teaching sessions.
- It was noted that some of the undergraduate students did not really understand its purpose in relation to design practice or their projects, but allowing individuals to experience and encounter themselves was fundamental. Facilitating this practice may require experience in meditation (or invite an expert to facilitate).

Feedback and reflections from students:

- For some undergraduate students who were not interested in meditation, it may be seen as a pointless activity. The facilitator needs to explain that being mindful about nature is part of their whole learning journey.

Lessons learned:

- The self-observation into nature improves our capacity to react individually to what nature is telling us.
- Practicing mindfulness meditation can be used in the classroom and in everyday life. It is hoped that future design graduates entering professional employment will continue to use such practices.

Figure 44. Postgraduate students in the mindful meditation session and mindful movement with Kumanga Andrahennadi. Picture credits (Andrahennadi, 2013)

Research Explorations (3.1.d) -Activity 4. Movement
Observations by the Researcher: • It was not until the second exploratory workshop that ecosomatics were introduced. This stage was refined thanks to the participation at the MDP workshop with postgraduate students, where mindful walking was included. For some students not interested in meditation, these practices can be experienced as a more playful activity that will be remembered as part of the whole learning journey. • Some students were unenthusiastic about the Mindful Movement activity at the beginning, but their attitudes changed after they experienced the bio-extended game. Feedback and Reflections from Students: • The evaluation surveys conducted after this module revealed that the students enjoyed "some" of the activities. • The Master's students acknowledged that the practices were very valuable in achievin their learning. They also indicated that these methods could be used at the taught postgraduate level in the future. Lessons learned: • The students that might consider some of these meditational exercises to be awkward or pointless. As the facilitator, you must be slow and patient during the demonstrations. Give additional explanations after the practices about the meaning and value of such exercises. • Practicing mindfulness increases our sense of self with-in the world; constant practice can grow into enlightenment, compassion and transformation. • With these activities, the students can find an affinity within group and self-development.

Figure 45. Students in a walking meditation

Research Explorations (3.2.a) -Activity 5. Seeing

Observations by the researcher:

- Encouraging curious questions related to the species that the students are observing is recommended during the drawing phase, i.e. what do you think the function is or what do you thing about its color? Why is the branch pointed in that direction?
- Group drawing can help build the confidence to 'design together' and can open pathways to see how others perceive the same phenomena.

Feedback and reflections from students:

- During the first pilot workshop, the first five steps were developed through following a template and were then evaluated. Responses from the questionnaire indicated that some of the steps were difficult and required more time to complete. During the second workshop, inviting an expert reinforced the steps and enabled a group version to be conducted.
- The facilitator needs to be vigilant, as some of the students finished early whilst others required more time. One student commented: 'It is a very personal thing'. Be mindful to allow some additional time for the drawing phase.
- The Master's students' evaluation of the steps was discussed and it was suggested that adding a collective concluding exercise would be beneficial.

Lessons learned:

- The Goethean method requires years of study. However, the steps explored in this research study were modified into a short version that can be applied to the development of a short course or workshop.
- A written guide should be provided to support the students in the first five steps. Following the instructions in a playful way (i.e. a folded sheet without seeing all the instructions at once) helped them to make sense of the activity and to explore in solitude.

- Some students required more individual guidance during Steps 4 and 5, as they found it difficult to understand. It may be important to add another step that links their background as designers; for example, asking them how the plant might inspire a design or how the plant is communicating with them?
- By mentioning to the students that this observational activity connects to the previous practices of meditation, we deepen the sense of seeing.
- The use of the Goethean method can be considered a very effective tool, especially if is practiced over time. It is good to recommend that the students study this method following the class.
- It is worth explaining that this method will be used in conjunction with the biomimicry methodology in a further practice of analysis of organisms.

Figure 46. Students practicing the Goethean Method individually and in a group

Research Explorations (3.2.b) -Activity 6. Lensing

Observations by the researcher:

- Any kind of documentary about wildlife, ecosystems restoration or problems of humans' exploitation of nature were good examples of engaging with nature. Clips shown were greatly enjoyed by the students.

Feedback and reflections from students:

- These exercises were tried only once and require further implementation. Nevertheless, it was observed that the students enjoyed the performance, as indicated in the research questionnaire (See appendix B.3).

Lessons learned:

- Indigenous ways of interacting with non-human beings require further exploration, and can provide a sense of place, awe and wonder.
- Further development of non-human centred design tools are needed. This especially relates to the capacity to become or 'think like' another organism, which can provide a new design lens.

Figure 47. Students in deep conversation with a non-human being

Research Explorations (3.2.c) - Activity 7. Wondering

Observations by the researcher:

- Documentation of experiences was compiled both during the practical exercises and walks in the selected natural classroom and also in student's spare time at home or on their trips to the countryside.

Feedback and reflections from students:

- The research questionnaires completed after the class helped to provide feedback on the teaching, the educational material used and the acquisition of biophilia vocabulary in the students.

Lessons learned:

- The curiosity exercise involves self-learning following hashtags or keywords. Freedom to explore the internet or library is allowed but warn students to come back with brief information and real samples.
- Remind the students to use previous exercises such as observations or meditation when visiting a space to collect samples.
- As a homework exercise, you can suggest that students collect a few images of the animals or any other natural organisms to which they are most attracted, maybe their recent favourite.
- The use of audio-visual images of biophilia may need to be carefully selected and must be appropriate for the project on which the students will work. E.g. If the project is about 'designing a community', perhaps show a documentary on 'wildlife communities.'

Figure 48. Students doing observations and collecting samples

Biomimicry

Research Explorations (4.1.c) -Activity.1 Bio-inspired stories

Observations by the researcher:

- The research questionnaire included questions related to the audio-visual material and exercises presented to the students. This helped to mantain a collection of resources and to find out if the students liked the content or not (See Appendix C.3).

Feedback and reflections from students:

- Providing the students with a list of activities for the workshop was helpful in letting them follow the same dynamic of learning about biomimicry as an eco-technique (For a sample of a day's agenda, see Appendix C.4).Lessons learned:
- Compiling and presenting examples of biomimetic design needs to be undertaken, along with outlining the different synonyms of the term biomimicry, and explaining how the term has evolved over time. It is recommended that you also present clips and videos of examples.

Figure 49. Visual presentations by the researcher

Research Explorations (4.1.d) -Activity 2. Recognizing the Principles of Life

Observations by the researcher:

- Using printed labels and samples on the table makes the activity dynamic and playful. It also allows students to learn from each other as they describe their samples, comment on the labels and differentiate natural design from those of humans. Allowing the students to experience this exercise outdoors, where they can find natural samples, is a good way of enhancing the quality of learning.

Feedback and reflections from students: None

Lessons learned:

- Reminding the students to use the template 'Life's Principles' as a compass for their project will help them to study the source of inspiration in greater depth and create a meaningful design concept.
- Using mixed educational material is a sign of the facilitator's interest and involvement in teaching biomimicry. Designing original material promotes sense-making and is a way in which biomimicry education is delivered.

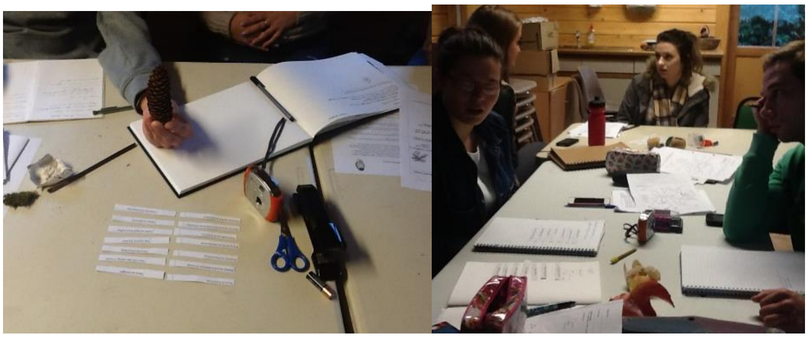


Figure 50. Images of students learning biomimicry methods

Research Explorations (4.1.e) -Activity 3. Focusing

Observations by the researcher:

- A brief was explored through a pilot workshop which incorporated a need to be solved through the biomimicry methodology. Here, it was observed that the biomimicry practice, and the previous biophilic practices, developed the students' creativity and ethical decision-making around their project.
- The template that was designed and tested helped to break down the design brief and identify a real need in a local and global context. Placing the problem in the local/global context to then explore appropriate forms, functions, processes or systems of an inspiring organism or a group of organisms, is a divergent process that activates the students' naturalistic understanding of design.

Feedback and reflections from students: None

Lessons learned:

- In order to develop a more accurate direction for the design process, the brief must be based on general societal needs; for example, food, communication, transportation, housing, water, education, health, trade or governance. It should then direct the focus to a specific design task; for example, community, animal shelter, tools etc. These example were characterized as real emerging world problems or fast-changing subjects that can only be solved through interdisciplinary efforts. For example, the way in which the team started to ideate with nature was connected with the basic exploration of their theme "community" (See Appendix A.5) and the connotations of their selected focus, i.e. transportation systems. In a brainstorming session, the students started mapping out the synonyms, interpretations, values and ideas to approach both concepts. This approach took them to the systems level, and furthermore, the individuals and teams started focusing on a form, process and the whole system itself, guided by the chosen organism or ecosystem.
- The design brief given at this stage, after the biophilic practices, indicate the importance of the preparation stage in begining to identify the sources of bio-

inspiration. This aspect of the design process entails the capacity to analyze the theme, context and problem from nature's perspective and to develop solutions that prioritize the 'Principles of Life'.

- At the ideation stage, divergent thinking is enhanced through biomimetic design examples previously presented by the teacher. It is important to support the examples with videos and reading material related to the studied organism.

Figure 51. Students using research templates

Research Explorations (4.2.a) - Activity 4. Rediscovering

Observations by the researcher:

- This method to gather information was tested in a team situation. Team work was important to identify diverse functions. The teams were able to embed diverse functions and different organisms. Support from the teacher or biologist was important in the generation of concepts and their selection.
- The established methods that were analyzed helped in the design of Template 2 for the selection of meaningful keywords, functions and concepts that resonate with the need that the designer or team of designers identified in the pilot workshops.
- At the end, the students focused on what they had observed at the Dundee Botanic Gardens. Some students consulted academic papers. The majority used the usual design process, continuous sketching and mind maps.

Feedback and reflections from students:

- Template 2 requires guidance as the students sometimes find a preliminary design solution, not a need.

Lessons learned:

- Template 2 required a further redesign to integrate biology research with design research.
- Revisiting the Goethean method at this stage is fundamental in observing the organism, material or system. When we observe a natural pattern, the imagination increases.
- In the experiments conducted with the design students, they were instructed to use a specific method. However, it was recommended that they consult the internet, and most of them used a web search engine or the university library website for databases and academic papers. Some of them used sites such as AskNature (http://www.asknature.org) from the Biomimicry Institute, displayed as the most popular website. Another engine that was recommended was EOL – Encyclopaedia of Life (http://eol.org).
- The students can get lost in their fascination for the organism, which can result

in collecting lots of information but missing the key research questions. Their capacity for researching an organism or various organisms sometimes took them into the analysis of more academic papers, databases and technical questions than was needed. It is important that the teacher helps to focus on the needs identified and the information to research.

- It is necessary to make a presentation preview of the project at this stage, before making a mock up or a 3D representation of their design proposal. This will allow evaluation and identification of failures, and it can then be refined in the next stage of the SDP.

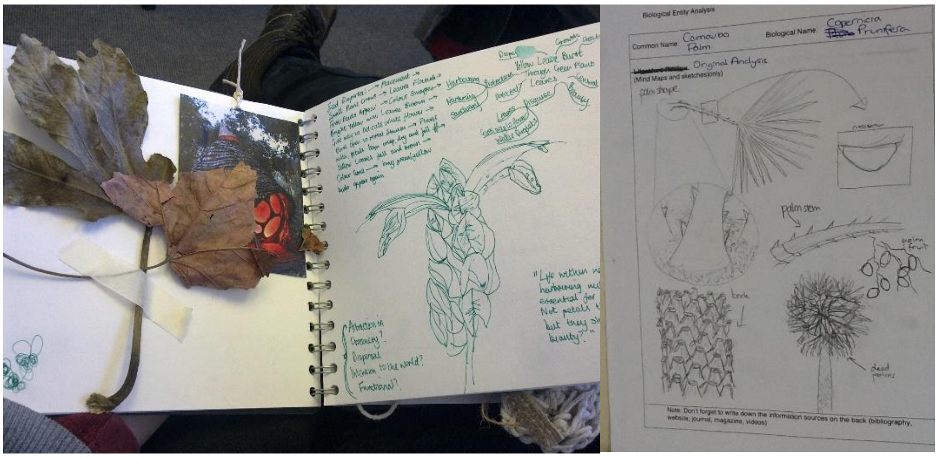


Figure 52. Sample of students' material for collecting biological information

Research Explorations (4.2.b) - Activity 5. Prototyping

Observation by the researcher: None

Feedback and reflections from students: None

Lessons learned:

- It is necessary to make a preview of the project at this stage, before making a mock-up or a 3D representation. This will allow students to evaluate and identify a future scenario in the next stage of the SDP.
- Invite a biologist to the preview as it is important to check scientific terminology and ethical implications, and they can suggest further explorations regarding forms, functions, processes or systems from other resources.

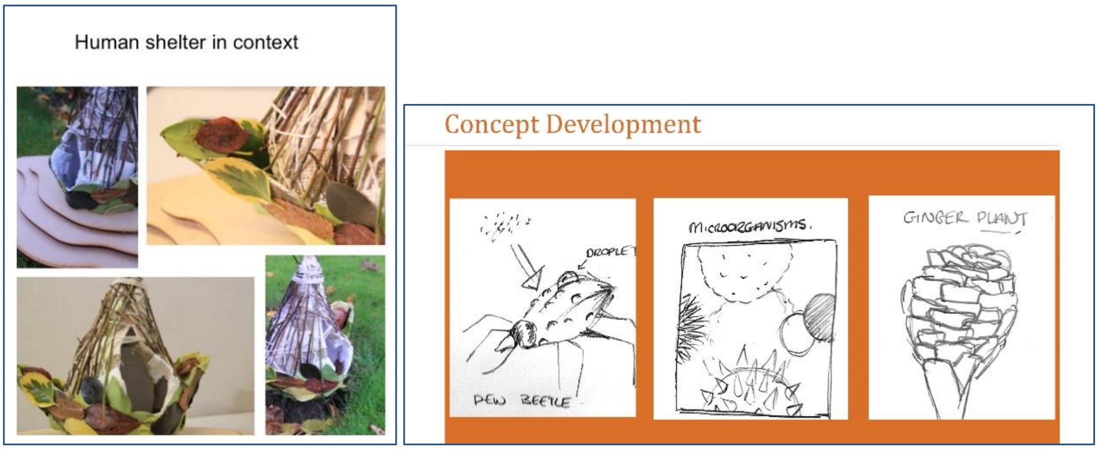


Figure 53. Sample of students' conceptualizations and prototypes

Research Explorations (5.1.b) -Activity 1. Thinking Resilience

Observations by the researcher:

- With the introductory presentation and the completion of the game, students began to think in systems, reinforce their knowledge on ecosystemic interactions and understood complexity.
- At this stage, the students really began to think of possible effects of their designs in a bigger context.
- During the first pilot workshop, this exercise was not directly linked with the next exercise (*The Resilient Island*). The use of the 'Natural Systems' stickers in another exercises helped the students to understand the narratives about ecosystems and resilient society.

Feedback and reflections from students:

- The students enjoyed the playful activities, especially outdoors, as expressed in the research questionnaires (See Appendix D.2).

Lessons learned:

- An activity using a template called '*Systems Thinking – Community Map'* was tested with very poor results. At a taught postgraduate level, feedback from students indicated that the activity needed more guidance. So it was decided not to include it in the final series of workshops.

Figure 54. Students participating in resilience thinking activities

Research Explorations (5.1.c) -Activity 2. The Resilient Island

Observations by the researcher:

- In the pilot workshop, the material was provided for the island activity. During the second and third workshops, students were asked to find the materials outside, which resulted in a fun experience.
- In the first pilot workshop, groups were given little flags to identify themselves in the islands they made, however, the stickers were not used in the second step, allowing for self-identification. This created better dialogue within the groups.
- In the first pilot workshop of Step 6, 'unexpected event', the teacher was the one who performed the unexpected event, and in the second workshop students performed the event with their own groups. What was noticed in the second iteration was that the emotions of causing the unexpected effect were more profound, creating a bit of discomfort within the teams.
- Because all students in the groups contributed to shaping, reshaping and reconstructing the islands, a sense of cooperation emerged, showing one of the main features of resilience thinking.
- One action observed was that the students took pictures of the island witsh their mobile phones. Some of these photos were included in the reflective submission activity, which demonstrated that they enjoyed the activity.
- With the idea of the unexpected event, the students became aware of responding to natural patterns, generating the idea of resilience. The idea of hope was also seeded. Nevertheless, one of the reactions observed was that the mood, upon receiving the instruction to reconstruct, was very low.

Feedback and reflections from students:

- In the first pilot workshop, the activity steps were printed and given to each of the groups. In the second iteration of the activity, the instructions were given orally, and this appeared to be more effective. Feedback from the workshop with postgraduate students indicated that both written and oral instructions should be used in future.

- A reflective review/postcard was very successful, as the students expressed after the activity; this was also included in their final submission.

Lessons learned:

- In the first pilot workshop, students were divided into two groups and allocated different rooms and materials, which caused some curiosity and distraction, as they wanted to see what the other group was doing. During the second workshop, the students were placed in the same room but at different tables. It was observed that the students were working more fluidly and at the same pace.
- During the pilot workshop, the creation of mock-ups worked well. However, during the second and third workshops, the activity had to be suspended due to the time available. As such, students went directly to the reflection part of the exercise.
- During the artificial effect in step 4, better explanations were needed about the limited resources available in the islands and the materials that were handed out. This action symbolized the shortages on the planet.
- One recommendation is to tell stories about the names of places. Many cities or towns are named depending on the topography or local natural resources available. This reflects the idea of being indigenous to a place.
- To reinforce the ideas of the resilient island, it is recommended that the facilitator present a documentary or clips containing stories about the lifestyles of indigenous communities or ancient civilizations; for example, the history of EasterIsland (See Appendix D.3).
- With this activity, the students understood the idea of pulsing and scale-linking, acquiring a holistic sense in our human endeavours. Ideas of self-organization and complexity were reinforced.
- Making mental or written mind maps of the island helped to further develop systems thinking. This activity helped students to consider a range of choices, and to visualize and measure the options that might work in design proposals.
- By becoming a natural/human effect on the shape of the island, as we do with our planet, the activity helped students develop a sense of coherence, promoted ethical values and reaffirmed the ideas of Gaia theory.

Figure 55. Students' interaction with the 'resilient island' activity
From top right: 1. Materials given to students on pilot workshop. 2. Students collecting natural materials. 3. Students on pilot workshop on 'designing an island'. 4. Groups of students in the classroom interacting and discussing resilient communities.

Research Explorations (5.1.d) -Activity 3. Forecasting/Backcasting

Observations by the researcher:

- In the first pilot workshop, this exercise was not applied. It was not until the second workshop, based on the idea of Template 7. *Bio-Civilization* (see appendix E.5), that this step was needed. It was applied in the final workshop and in other postgraduate workshops with great success.

Feedback and reflections from students:

- The students mentioned that the format of drawing was very fun but it requires more time to generate a narrative.
- In the review workshop with Master's students, they suggested that the instructions needed to be clearer.

Lessons learned:

- A presentation on forecasting/backcasting methods, or futurism, is recommended before this activity.
- Linking these methods with the work in progress (or prototype) needs more development.
- In the workshop with postgraduate students, the exercise using forecasting techniques was very successful in helping to design new templates for further workshops.

Figure 56. Students working on Forecasting activities
From left. 1. Postgraduate students designing future services.
2. Undergraduate students using template 6 forecasting on workshop 3.

Research Explorations (5.2.c) -Activity 4. Evaluating Resilience

Observations by the researcher:

- Placing the consequences of a design in the larger context regarding life's principles is a more evaluative method.
- Overall, the exercise demonstrated the ideas of reflection in order to reframe their final design concepts.

Lessons learned:

- Presenting videos or readings on indigenous ways of living is an important feature in demonstrating elegant frugality and gentle action at this stage (See Appendix D.3).
- Presenting a schedule of the day and the aims of the workshop on resilience (See Appendix D.5) helped the students to keep a record of what they have learned.
- By presenting a list of Permaculture design principles, or revisiting biophilic values and ecological design principles, biomimicry life's principles can be used to evaluate the ethics of a design from a holistic perspective. The teacher can suggest that the students design their own lists or add more principles.

Figure 57. Students self-evaluating their final design proposals

Research Explorations (6.1.a) -Activity 1. Our Bio-culture

Observations by the researcher:

- In the first pilot workshop, the instructions were too abstract for template 7. In the first design on the template, there were two squares with a line that represented the way we live in the world: Linear (a straight line is entitled 'Our Culture'). The second square represented the organic way of life that we want (with a curved line entitled 'Our bio-culture'). The results were quite surprising; students' designs ranged from very detailed landscapes to cityscapes.

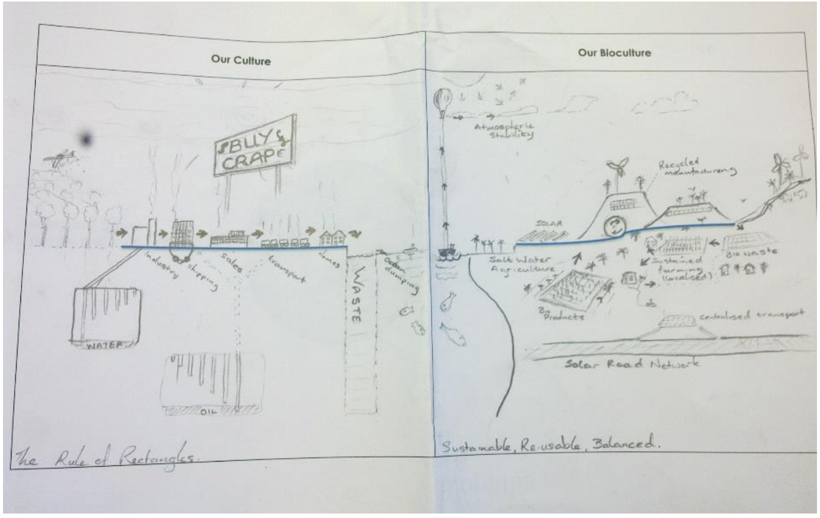
- In the second pilot workshop, the exercise was redesigned to include 3 squares. In the first frame, 'our primeval bio-culture', the organic line represented the origin and the way nature has existed, which illustrated a pristine, wild and primeval civilization. In the second frame, the word 'present' depicted our current human endeavours as a narrow-minded, scientific, linear and cold way of experiencing the world. The final frame, defined the 'idea of the future of our culture' is empty, giving room for students to express their own ideas and perhaps to combine the previous frames. The word 'symbiotic', previously studied, gave an intentionality to shape this future for the benefit of humankind and nature. Adding the keyword lines to the drawing also helped to describe the values and ethics acquired.

Feedback and reflections from students:

- Feedback from students indicated that brief instructions should be added to the start of the exercise. To address this, colors for the frames and a line for keywords were added in the design of the template 7 (Appendix E.1).

Lessons learned:

- Both trials were effective in terms of drawing representation. In the pilot, the freedom to express ideas facilitated a great diversity. In the second workshop, the results were very similar and centred on the present moment of our culture.



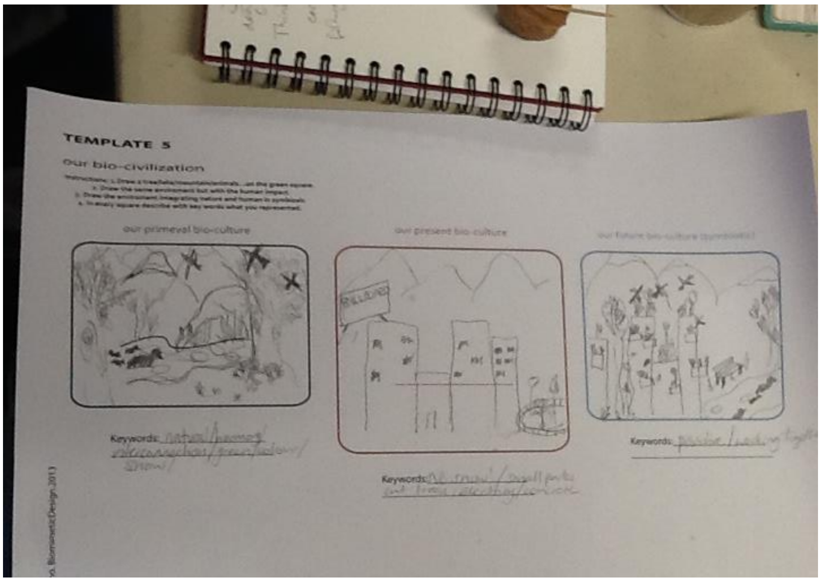


Figure 58. Former and final template 7 on thinking about our bioculture

Research Explorations (6.1.b) -Activity 2. Metamorphosis

Observations by the researcher:

- The basic premise of the metamorphosis activity initially arose from the development of a workshop centred on the concept of resilience. This workshop was conducted at the Future Connections Postgraduate conference in 2013, where the topic of sustainable development was the focus. The inspiration arose from the short video Papiroflexia, produced and illustrated by Joaquin Baldwin for the Pangea Day (See Appendix E.2). Papiroflexia tells the story of a man who was oblivious to the outside noise of a polluted city whilst creating origami creatures, and this subsequently started a journey of transformation. The objective of this workshop was to provide new concepts and tools for policy makers, architects and designers who were studying sustainability. The concepts of Resilience and Biomimicry were the main focus. Through a playful origami exercise, the attendees were immersed in a process of folding, unfolding and discovering new ways to solve problems by being inspired and learning from nature. The concept of resilience, along with the idea of forecasting, was also introduced to help redefine sustainability and ecological thinking. By combining these concepts through instructions and playful activities, the attendees explored how the concept of sustainable development could be complemented or redefined.

- Subsequently in further iterations, the format was refined and adapted depending on the topic of learning.

Feedback and reflections from students:

- In every iteration with the undergraduates, the students expressed that they liked the origami activity. They took pictures and kept the template now in a form of a butterfly.
- In the review workshops with Master's students, the effectiveness of the exercises was expressed and the right connection with the concept of transformation.

Lessons learned:

- The exercise was well received for its originality. Defined as a tool, the content of the exercise was subsequently adapted for the second workshop with undergraduate students. In doing so, it appeared that this tool could be adapted to suit the needs of students across different levels of design education and interdisciplinary boundaries.

- Various attempts were made in the design of the templates so as to ensure that the origami folding steps incorporated the appropriate activities and written content. As the activity was a way to conclude the series of workshops and to reflect on a learning journey, it revealed the transformation which has occurred by learning about the different topics across the module. For more information, see the Schedule of the Day (Appendix E.3).

Figure 59. Students enjoying the 'Metamorphosis' activity

Research Explorations (6.1.c) -Final Activity: Assessing the ecological learning journey

Feedback and reflections from students:

- After the conclusion of the exercises on symbiosis, direct communication with the student cohort indicated that the module was well received. In particular, one student commented that having an open brief at the beginning of the module was a challenge but was very rewarding as a whole process of learning. Other students also shared this view.
- By undertaking the project in interdisciplinary teams, students also expressed that they developed good, open channels of communication, thereby leading to the creation of new ideas and original concepts.
- They also recognized that systemic thinking became important in their formation as designers, especially the importance of natural systems and resilience.
- Other comments made by the cohort acknowledged how ecological thinking had helped them to visualize themselves as agents of change, especially how important it is 'to make a difference' in a world of anthropocentric despair oriented to a highly quantitative and machine-directed world.

Lessons learned:

- The university provided a survey in which the students validated the module, which can also be useful to compare with the surveys conducted by the researcher.
- The sessions with postgraduate students were useful in identifying aspects in the redesigning of the activities.

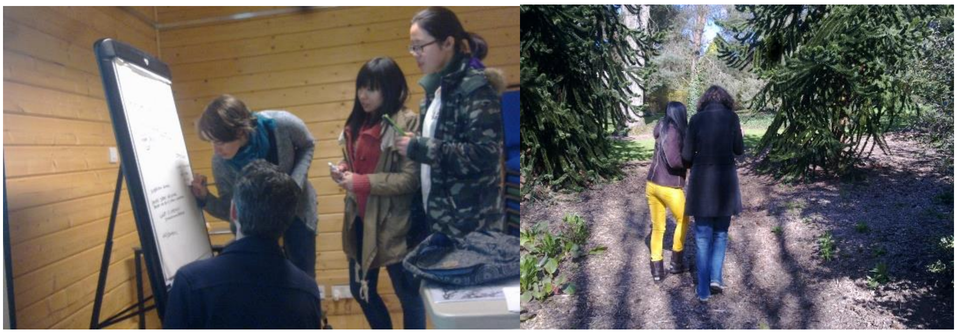


Figure 60. Postgraduate students evaluating activities and teaching material

Figure 61. Students presenting their final projects and learning journeys

Appendices

Appendix A

A.1 Conference Papers..400

A.2 CASE Award..452

A.3 Design Values Issues and Ethics' expansive module description..........................453

A.4 Initial research questionnaire and responses..457

A.5 Design brief..465

A.6 Reflective piece example..470

Appendix B

B.1 Audio-visual biophilia examples..476

B.2 Dundee Botanic Gardens description..477

B.3 Biophilia research questionnaire..478

B.4 Typology of biophilic values..479

B.5 Biophilia workshop agenda of the day..480

B.6 Ten mindful movements by Thich Nanh Han..481

B.7 Goethean Method Steps..484

Appendix C

C.1 Contemporary examples of Biomimetic design (by discipline)..........................486

C.2 Biomimicry audio-visual resources..489

C.3 Biomimicry Research Questionnaire..490

C.4 Biomimicry Workshop agenda of the day..491

C.5 Life's Principle canvas by the Biomimicry Institute..492

C.6 Life's Principles vs. Human Responses (adapted by Porritt)..493

C.7 Template 1. Biomorphize it/Anthropomorphize it..494

C.8 Template 2. Identifying the need..495

C.9 Template 3. Rediscover..497

C.10 Template 4. Biological Empathy Map..498

C.11 Template 5. Biological Research..499

C.12 Template 6. Natural Prototyping..500

Appendix D

D.1 Natural Effect/Human Effects labels..502

D.2 Resilience reflective piece example..503

D.3 Resilience audio-visual resources..504

D.4 Template 6. Forecasting..505

D.5 Resilience workshop agenda of the day..506

Appendix E

E.1. Template 7. Our Bio-culture..507

E.2 Symbiosis audio-visual resources..508

E.3 Symbiosis workshop agenda of the day..509

E.4 Template 8. Metamorphosis..510

E.5 Learning Journey Example..511

E.6 Final Assessment Examples..512

E.7 Final Questionnaire example..514

The wonder of design with-in Nature: towards an ecotechnic future

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Abstract

Seeing the Earth as a crafted entity is more than a metaphor; forms, processes and systems embedded in all the biodiversity have been creating a living atmosphere and inspiring human creativity for thousands of years. In the age of biology, our digital technologies and sustainability models are re-shaping our culture to flow with the patterns of the natural world. Biophilic trends, biomimetic practices and the search for natural rhythms within our technology are now co-forming a state of transition which recognizes the intrinsic intelligence embedded in animals, plants, fungi, bacteria or even human off-grid communities. This paper describes these practices as eco-technics, and considers the role of the design academy in fostering sustainable scenarios, thereby establishing an opportunity for design innovation and a way of seeing the world anew through the eyes of nature.

KEYWORDS: biophilia, biomimicry, resilience, future scenarios, synergy, design education

In the age of biology: introduction

Future, the most inspirational and stimulating word, contemporarily means a perspective of growth and prosperity. As a natural species, this means surviving, growing and flourishing in times of rapid change and uncertainty. Nowadays, those working in the field of biotechnologies proffer a scenario in which self-organizing robots (Murata, et al. 2012), living buildings (Armstrong, 2012) and high performance humans (Rifkin, 1999) will reach meaningful lives through self-regulated artificial environments. Nevertheless, conscious of the many concerns about manipulating genes, consumerism and industrial dependence, there is another possible world of low-technological advancements and sustainable developments that consider a harmonic descendent rhythm (Greer, 2008) and a transition to resilience (Hopkins, 2011). Here, an altruistic human sense of permaculture (Holmgren, 2002), eco-literate communities, zero waste industries and craftsmanship seeks to change those technologies that have been disrupting our natural environment. This altruism is a realization of the human spirit that is now looking to maintain healthy levels of interrelationships as part of a living planet that continues changing naturally and artificially.

Hugh Dubberly, suggests that we are now shifting from a mechanical-object ethos to an organic-system ethos and, as such, we must figure out the role of design in an age of biology (Dubberly, 2008). This, Dubberly says, will create new industries, bringing about profound cultural shifts and many new changes in our view of the world and our place in it. This notion raises the need to promote a clearer vision of resilience and ethical practices in order to develop a deeper understanding of our biological functions and technology which will be applied in our daily life.

Why do we need to establish a permanent dialogue with the natural world in the pursuit of answers for the realization of our contrasted design utopias? What is the fundamental strategy to start such a dialogue? In order to answer these questions, this paper argues for a reflection on three connected issues: *biophilic* trends, *biomimetic* futures, and *resilient* scenarios. This situates the design academy as the embryo from which to start the development of such strategies in order to create meaning and hope in the making of the future now in the age of biology.

Biophilic trends: a way to being with nature

Imprinting deep symbolism, as a result of our maladjusted worldview and turbulent future, Carl Jung wrote of an urgent need to rescue our naturalistic consciousness:

> *"As scientific understanding has grown, so our world has become dehumanised. Man feels himself isolated in the cosmos, because he is no longer involved in nature and has lost his emotional 'unconscious identity' with natural phenomena. These have slowly lost their symbolic implications. Thunder is no longer the voice of an angry god, nor is lightning his avenging missile. No river contains a spirit, no tree is the life principle of a man, no snake the embodiment of wisdom, no mountain cave the home of a great demon. No voices now speak to man from stones, plants, and animals, nor does he speak to them believing they can hear. His contact with nature has gone, and with it has gone the profound emotional energy that this symbolic connection supplied"*(Jung, 1964)

This conceptual vision clearly resonates in the design academy but it also needs to do so in the education system in order to begin the change to a divergent thinking thereby transforming boundaries into an organic-system ethos.

Biophilic practices through design fills the gap of ethical needs in an exercise of "being with nature". Biophilia, described by E.O Wilson, is the innately emotional affiliation of human beings with other living organisms(Wilson, 1990). He adds that life around us exceeds in complexity and beauty anything else humanity is ever likely to encounter. More recently, Stephen Kellert advanced the notion of Biophilic design (Kellert, et al. 2011), that refers to stimulating our sense of coherence with the natural world. Its recognized actions also build a sense of the co-evolution of human infrastructures making them more aesthetically appealing and nourishing.

Animal shelters, coral reef restoration, urban farming, natural reserve preservation, even ethnographic reconciliation through the rescue of indigenous crafts are part of this biophilic sense that brings metaphysical approaches into design. These intentions to implement strategies for catching rainwater, growing food locally or crafting zero waste just for human beings are aimed also to facilitate integral efforts for the wellbeing of bees, mangroves or sea creatures for example. If design is broadly defined as intentionality expressed through interactions and relationships (Wahl & Baxter, 2008), then the design academy is the main actor in reframing our worldview and value systems which shape the way we relate to nature and the connections with the rest of the community of life.

A Natural Future

In the last decade, a myriad of concepts, preformed by sustainable design and ecological issues, have begun to emerge in design institutions, scientific groups, government projects and eco-communities. Producing fuel from *algae*, designing photovoltaic *trees*, planning of *metabolic* cities, *fractal* social media or investing in *nature's services* creates a new lexicon revealing an invisible layer that looks for a re-connection with nature.

Most academic teaching and learning modules related to sustainability or ecological design recognize that living systems add intrinsic value through bio-inspired products, environments and services. Forms, textures, materials, colour and functions found in the micro–macro natural world have not only a physical purpose but also a cooperative purpose. This holistic worldview accepts that animals, plants, fungi and bacteria are not longer just a symbolic part of an alien landscape but are proper designers, engineers and unique beings that are part of an emerging innovative culture, where through the open connexion with design, life sciences and bio-engineering are revealing hidden patterns.

The conscious emulation of nature's genius, as advocated by Janine Benyus (Benyus, 2002) has been present ever since the human species has interacted and participated with all natural phenomena. Emulating silk worms, bird's flight, seed transportation or studying ecosystem strategies in physical objects, services or communications is now easier with the integration of digital interactions and the power of visualizing tools at a microscopic level. Biomimicry, as an emerging discipline, has begun to create multidisciplinary participative networks. Its innovative methods are linking together not only designers, engineers and scientists but philosophers, futurists and entrepreneurs in a dynamic cross-communication, from the arts to the sciences.

Computational morphogenesis, additive manufacturing and evolutionary algorithms are also a reality (Menges, 2012). These emergent technologies are also beginning to translate the wisdom of nature into a synthetic biology in practices that we cannot ignore. We have to recognize that we need to operate rationally and meaningfully in responding with creative decisions and interventions for the sake of a healthy planet.

This brings opportunities full of possibilities for the design academy. Biology in design, along with ecology and biotechnology, open the doors for a new kind of research, where the prototyping of future scenarios can be more appealing to our living planet and the communion with the web of life. Structures, colours, gestures and textures in all biodiversity reflect an intention to communicate this integration with the biosphere. Any design programme must therefore take into account the mutually beneficial strategies that biodiversity can teach us.

The shift to mimicking of non-human design plays a significant role in problem solving, by seeing the world through a different lens as described by Fraser Bruce and Seaton Baxter (Bruce & Baxter, 2008), thereby increase the sense of perception, creativity, emotion and communication of phenomena as a way of seeing nature. If all living things are to be meaningful and intelligible to us, promoting its own designs, then we require a lens that not only reflects its knowledge through physical but also through ethical attributes. These biomimetic practices and methodologies are beginning to show a way to create a future to "design with nature".

Resilient scenarios: Finding a natural rhythm

Our inner human instincts in the understanding and transformation of our world will correlate well with how eco-literate and techno-literate we become. Technophilia will continue to advance, helping to maintain and upgrade our living standards, and Biophilia will provide a link with our husbandry of other species. Nevertheless, as David Stairs maintains, the split between nature/culture is imminent(Stairs, 1997).

In order to ignite healthy and ethical relationships between technophilic and biophilic practices in the future we require *symbiosis*. In biology, this term means an interaction between two different organisms living in close association, typically to the advantage of both (Margulis, 1991). Kisho Kurokawa reveals this practice by depicting the age of the machine and the age of life. In the former, he criticizes universality, purity, dualism and human superiority; in the latter, he calls for a creation of meaning through diversity, plurality and principally symbiosis (Kurokawa, 1994, p.28). He differentiates symbiosis from harmony, compromise, amalgamation or eclecticism, in that symbiosis is made possible by recognising a reverence for the "sacred zone" between different cultures, opposing factors, different elements and between the extremes of dualistic oppositions. A second element is the sense of an "intermediary space" as a definite thing that does not exist because of its extreme tentativeness and dynamism, but finally incorporates opposition. Physical and metaphysical, high-technology and low-technology, arts and sciences require this mutual understanding of opposing elements, where all its ambivalence, multivalence and vagueness, as Kurokawa argues, are in continuous transformation and metamorphosis, as the image of nature.

This need to project that symbiotic consciousness provides opportunities for the design community, as facilitators of those intermediary spaces, to explore interventions with the life sciences and other open specialities that want to craft biological futures. This kind of consciousness could be referred to as 'natural design', where deep cooperation between human and non-human purpose converges. Nevertheless, it will require the design academy to be capable of opening up platforms for this radical but innovative way of engaging with our planet. Future design practice needs to reconsider technophilic and biophilic practices symbiotically in order to understand deep relationships, between natural organisms and our technological desires. These establish an ethical natural rhythm in the development of utopic scenarios and innovations, or in other words, a technological significance that reflects nature's intention.

At the beginning of this century, the tracking of trends is becoming more and more difficult. The narrow vision of the mechanical-object ethos still remains in the structure of our education system affecting the conformation of institutions, networking participation and finally the technological flux. Nevertheless, urgent sustainable strategies about peak oil and global warming are influencing the way we make the future. Small scale, slow solutions and biological patterns are creating a state-of-transition and the need for resilience.

In a ten-year forecast titled "A Century of Transformation, A Decade of Turbulence" the members of the Institute for the Future (Morrison, et al, 2012)explored six fundamental shifts that will shape the century to come:

- » Hyper-urbanization: From strategies of enclosure to open strategies for the shareable city
- » Deindustrialization: From pipeline infrastructures to agile energy ecosystems
- » Dematerialization: From large-scale manufacturing to just-in-time manifestation
- » Social Production: From institutional wage labour to networked micro-contributions
- » Information Intensification: From information overload to cognitive prosthesis
- » Biomolecularization: From individually responsible intelligent organisms to complex ecosystems of biologically distributed intelligence

In their argument, they point out that these transformations will take a century to fully play out and will present us with a turbulent decade where the incumbent paths clash with the emergent paths and seemingly impossible scenarios may well prove possible. We can compare this scenario with the one proposed by Donella Meadows (Meadows et al., 2004) in the 'Limits to Growth' scenario, where industrial outputs, resources, population, food and pollution patterns are in an interrelated descent. This proposed state of the world is consistent with David Holmgren's four energy futures which are based on projections of past trends extending back over a human lifetime and drawing more broadly on patterns of industrial revolution and capitalism; *techno-explosion*, *techno-stability*, *energy descent* and *collapse*(Holmgren, 2009) are all considered part of the wide spectrum of culturally imagined, and ecologically likely futures, now in biological transition.

John Michael Greer also writes about these future scenarios within an eco-philosophical perspective, recognizing that we need to search for processes that appear across the range of ecosystems in the nonhuman world and then look for their equivalents in human affairs (Greer, 2009 pp.240–246). He considers three patterns:

» Cyclical patterns: Rhythms of rise and fall, which are present in the history of civilizations as well as in natural ecosystems. This allows a degree of prediction when human society expands beyond the limits of its environments. Time scale: centuries.

» Succession patterns: a process that replaces R-selected social forms with a series of k-selected forms, where the climax community remains stable until changes in the environment disrupt it. Always subject to change. Time scale: millennia

» Evolutionary patterns: cultural evolution that gradually accumulates useful techniques and leverages, by way of some previously unused resource base, into a sudden leap into a new form of human ecology. It branches outward along whatever lines for advance may be available. Time scale: lifespan of human specie.

He merges his conclusions on these patterns into a future where we become sufficiently conscious to consider human activities through *nature's eyes*: seeing ourselves as one specie among many, uniquely gifted in some ways but far from unique in others, and subject to the same changing natural laws. Connected to this notion, Freya Mathews suggests that until we, like all other elements of the ecosystem, weave ourselves into nature's synergistic net of desire, wanting what our eco-others need us to want, no amount of clever biomimetic design of our products, services and communications will ensure the integration of those into nature (Mathews, 2011).

We must also realize that we can't do it just with our own designs and our own organizational strategies. If the design education system looks through the lens of nature, this will be a fundamental link in creating a "sense of coherence" in human intention. According to Antonovsky's salutogenesis theory, this sense is divided in three elements: comprehensibility, manageability and meaningfulness(Antonovsky, 1979). For Antonovsky, the third element is the most important. If a person believes there is no reason to persist and survive and confront challenges, if they have no sense of meaning, then they will have no motivation to comprehend and manage events. His essential argument is that salutogenesis depends on experiencing a strong sense of coherence in predicting positive health outcomes. Daniel Wahl proposes that the search for salutogenic designs (Wahl, 2006), will transform consciousness in design communities and their intention to converge with thinkers, craftsmen, scientists and artists for a common action for planetary health.

The latent image of a turbulent but descending future raises questions that call for a natural unison. Slow manufacturing and low technology like many crafts around the world, are 'nature based', where the 'sense of place' is demonstrated in the local materials, biodiversity richness, spiritual meaning and seasonal adaptation. Local flora and fauna, can give us clues on how to mitigate consumerism by harvesting the right quantities of energy, growing materials locally, transforming, distributing and recycling.

Ecosystemically, materials are shared e.g. with a mountain, with a lake or with an ant. Projecting this sensitive worldview can encourage designers to innovate-with-nature and generate an organic flow. This kind of flow is represented by the use of rough materials and local techniques where most indigenous communities have been rescuing and transferring the wisdom of nature. If we are able to imprint that wisdom in our designed objects and services, then the opportunity to recognize these frugal actions is now.

The idea of frugal innovation(Radjou, et al. 2012) and gentle actions(Peat, 2008) are reflected in local gardeners, farmers and craftsmen. It can now be rescued by design disciplines and merged with suitable techno-digitalization. This radical vision contrasts with high specialisation which is no longer needed to produce a massive change. If "Civilization" as Gandhi once said, "consists not in the multiplication, but in the deliberate and voluntary reduction of wants" this envisages a descent scenario in futurising techniques that are now acquiring a biologic sense and a natural rhythm for our human endeavours.

Rupture in the planet happens when the thirst for development appears and pursues maximization. We must begin to conceive a continual state of flow, as ever-present but ever-changing provisional products, communications and services. For example, when we think of a product as a fixed entity, we start accelerating resources and forcing ideas. Seeking patterns of regenerativity, collapse or uncertainty, embedded in the natural world can be enabled by technology and innovative decision-making. Here lies a call to find resilience that reflects that biorhythm.

Resilience is a concept familiar to the ecologist. It refers to the ability of a system, from individual people to whole economies, to hold together and maintain their ability to function in the face of change and shocks from outside(Hopkins, 2008, p.12). At the boundaries of inconceivable futures, planned and emergent information needs to be connected into an all-mapped world where networking communities of expertise and non-expertise merge and respond in the middle of complex anthropocentric efforts. All of this whilst subject to change. Nevertheless, when facing technological mistakes or natural disasters the human-nature dialogue appears, promoting resilience and linking individuals, communities or populations organically, as Keith Tidball asserts(Tidball, 2012).

This is not just a matter of restoring, preserving or sustaining, but of 'feeling' the Earth as a truly crafting entity that changes along with us. Being sensitive to non-human designs is being part of a new creative scheme. A single specie could have many ways to communicate, cooperate and most importantly being with the world. This kind of engagement with the community of life is transcending green imperatives and sustainability trends at the design academy.

This concept is inspiring new ethical approaches that look for symbiotic participation in the act of designing for a living planet. If design starts to recognize that resilience can only be achieved if we establish that dialogue and practices with nature, then we need to establish the platforms to do so.

Making a Liveable Earth: towards an ecotechnic future

The three preceding sections lay out the grounds for 3 new practices in design: Biophilia, Biomimicry and Resilience. I call these *ecotechnics*, because they create the foundation to begin to work along with nature's patterns towards an ecotechnic future, as Greer foresees(Greer, 2009), bringing transition to an appropriate ecology in human culture, and translating it into a multidisciplinary design practice and philosophy.

Practicing the first two ecotechnics can reveal hope and meaning respectively. John Foster's argument of 'deep sustainability' (Foster, 2008) is a call to create consciousness about *life-meaning* and *life-hope* as an effort to frame ethical values in visioning future scenarios. Life-hope aligns with the concept of biophilia, resulting in a path to recognize the connections that human beings subconsciously seek with the rest of life forms in a common end, or in other words "design for nature". On the other hand, life-meaning aligns with the strategy of "design with nature" as a premise, aiming for an understanding of the language of animals, plants, bacteria and ecosystems as innovative tools, which is precisely the output of biomimicry.

Finally there is the biorhythm that weaves the idea of "change along with nature". E.O Wilson calls for an integral attitude for consilience or 'cooperation to flourish'(Wilson, 1999), a change of perception beyond conservation or preservation, growth or collapse but an ethos of multispecies cooperation. Resilience, then, encourages us to acquire a natural rhythm in our human intentions and technologies creating a sense of cooperation in order to thrive.

Connecting these three concepts will project a 'naturalistic' transition that we require for the wellbeing of human and non-human societies, known as Bio-synergy(Mathews, 2011). Implementing these practices will help to generate the eco-literacy required for the future. As inputs, the design academy will be capable of building ethical values, strengthening creative practices and providing critical views in decision-making about technology. As outputs, future graduates will be proficient in creating objects, communications or services which will reframe worldviews, principally establishing a re-connection with nature, the implementation of healthy innovation and crafting co-evolution with the planet. The table-diagram (1) illustrates this correspondence:

Table-diagram 1: New eco-technics in design education

Eco-technics	**Input by academia**	**Output by graduates**
Biophilia	Life-hope ethical values	Re-connection with nature
Biomimicry	Life-meaning creative practices	Healthy innovation
Resilience	Technological Bio-rhythm	Crafting co-evolution

This strategy is an appealing image of crafting our future where our recognizable biological ends look to maintain an ethical commitment along with our educational systems. We need to begin to establish programmes, modules and conformation of design communities that consciously bring a fundamental basis to promoting flowing change within nature and the limits of technology that human intention requires, thereby crafting a meaningful human presence on planet Earth.

This model will also place design in a participative mode moving along the continuum between the arts and the sciences and will stimulate the development of new methods to facilitate nature-based knowledge and behavioural change. Integrating these practices in the design academy on a continual basis will bring a new vital consciousness, encouraging design students and academic practitioners to 'innovate with nature'.

The participation of biologists, engineers, and other experts involved in 'naturalistic' practices, with designers is paramount. What if design educators promoted the connection of ecosystemic interactions with digital interactions? What if our methods of prototyping looked "through the eyes" of a red squirrel? What if teaching was undertaken in nature reserves or botanic gardens?, just to name a few examples.

The more conscious we become of the secrets of biodiversity embedded within our practical consciousness (Giddens, 1986), the more resilient our society will be. We require a shift to thinking about innovation inspired by nature, so that, artefacts, communications and services can be projected into bio-integrative technologies in the 21st century. Biophilic cities, biomimetic objects, metabolic services and ecosystemic interactivities will be part of a new lexicon in design and the elements of our culture.

Conclusions: Towards bio-synergistic practices

Nature is a design tool, a source of meaning and a source of knowledge. The emerging age of biology is bringing a spiritual shift of "being with nature". A transition momentum where the digital, economic and educational systems want to engage in a new ethic: re-connecting with nature.

Animals, plants, fungi and bacteria are also makers, engineers, scientists, craftsmen, gardeners and practitioners of an open access planet that, without interactions with human analogues, are unable to create this wonderful biosphere. The need to include this new naturalism through design is crucial.

The design academy has the power to develop holistic minds, which are fundamental to giving meaning and hope to the future. The ideas outlined here frame the beginning of a new philosophy where biological thinking and design thinking can create a platform in which we can craft with nature.

Biomimicry and biophilia are revealing non-human intelligence and conscious interaction with forest, seas, birds or insects. Resilience is bringing a sense of coherence to respond to descending and accelerating ever-emergent scenarios. Implementing these concepts as design practices can facilitate sensible, intuitive and ultimately mindful ways of connecting skilled minds towards bio-synergy: where mankind's intentions and nature's intentions converge.

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Biomimicry, Biophilia and Resilience as a partnership: Promoting design values, issues and ethics.

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Abstract

Exploring contemporary design values, issues and ethics was the purpose of a new module delivered to design students at Duncan of Jordanstone College of Art & Design, Dundee, Scotland. Using Biomimicry as a key driver for the module was crucial in establishing an understanding of the impact of design that has embraced natural systems thinking to explore conceptual opportunities. What made this project unique was the partnership of two key concepts, Biomimicry and Biophilia, to deepen the students' relationship with nature and its potential to inspire design. Using this partnership to align the concepts with Resilience gave the module a unique perspective.

This short presentation and paper is a reflection of these three concepts, as delivered throughout the module, and we will demonstrate the benefits of using this strategic relationship to enhance the design process. The value of this partnership is instrumental in promoting an ethos for design that is open, natural and explores the conscious and unconscious response of the designer. Exploring biophilic responses to nature allowed the unconscious awareness of the natural environment to develop the conscious response to design through biomimicry. Reflexivity for the designer is essential to evaluate and understand the effectiveness of the learning journey. Evaluating student feedback, we will highlight the effectiveness of Biomimicry, Biophilia and Resilience as a partnership for design learning.

Key words: biomimicry, biophilia, resilience, design thinking

Introduction

The reflexivity of the design educator is crucial in promoting a learning environment that encourages the exploration of one's ethical and environmental values within a contemporary context. To explore the learning environment for design we need to reflect on our past failures as designers and realise that we live in a society that is driven by negative economic forces rather than positive environmental ones. David Orr (2004) on questioning our education system asks, 'How do we teach [our students] to love land and community when our society values such things far less than it does individualism and consumption?' Orr suggests we are 'failing to equip them to deal with the consequences of what we are leaving behind'.

Given an opportunity to create a new module 'Design Values, Issues and Ethics', it provided the potential for design education to embrace a new set of principles that promoted a more environmentally and ethically driven design process. Using the UN Decade of Education for Sustainable Development 2005-2014 strategic goals for 'reforming education', and the Higher Education Academy recommendations (2009) for sustainable development within Higher Education Institutions, this module set out to formalise and deliver current and emerging issues impacting design practice within the professional landscape.

Recognising the value of design in improving the quality of life for humankind and the need for students to become aware of the relevance of environmental issues and ethical considerations as a natural part of their creative practice, the module promoted a holistic approach to theory and practice, enhancing the learning experience for the students.

Design Values, Issues and Ethics was an optional, expansive module, offered to level three degree students within Duncan of Jordanstone College of Art & Design (DJCAD), Scotland. The module had 15 students from an interdisciplinary range of subjects such as jewellery & silversmithing, illustration, product design, interior and environmental design, textiles, animation and graphic design. With such a diverse range of disciplines, a conscious decision was made to use biomimicry as the driver for the project, establishing an ecological perspective to the design process. Marrying this with biophilia gave the process a unique view of nature as it inspired not only the project but also the learning experience of the student.

The Design Process

The module used the design process framework REASON: Research//Environmental Evaluation//Analysis//Selection//Outcome//Nexus (Malcolm, J 2010) which places environmental evaluation within the research phase of the design process and emphasises valid importance on reflective practice as the link between the learning experience from one project, to its application on the next, providing a platform through which key principles can be driven.

To understand and realise the true potential of design within our world we need to acquire 'an affinity for life, earth, forests, water, soils and place – what E. O. Wilson calls Biophilia'. (Orr 2004, 129) This reference by David Orr to Edward O Wilson's concept of Biophilia is particularly relevant to this discussion. Wilson (1984, 1) suggests that 'to explore and affiliate with life is a deep and complicated process in mental development'. Wilson's reference to the 'machine' as a moment in time suggests it can have profound effects on the way in which we engage and interact with the environment in which we exist, at that particular moment. If the human species is a part of that machine, a cog that can turn one of the wheels, how can the designer, as a cog, use the wheels of nature to influence the design process? Wilson suggests we need a new way of 'looking at the world' (Wilson 1984, 2) that allows us to embrace our 'instinct' as a human species, thereby placing a 'greater value on [other organisms], and on ourselves'. If we consider that the use of our 'long-term memory' (Wilson 1984, 41) through our interaction with nature would influence our 'short-term memory', what learning experience can be achieved?

Adopting biophilic and biomimetic principles to influence and inspire design presented the project with an interesting complexity. To understand fully the relationship it is important we consider the way in which our conscious and unconscious responses to nature and design can act. As Wilson has noted, the 'long-term memory' can influence the 'short-term memory', and for this purpose we would suggest that there is a relationship between the unconscious 'long-term memory' and the conscious ‘short-term memory’. As children we engage with nature through acts of play, discovering a slug under a stone, or a spider crawling up a wall. We are not conscious of the influence of such interactions but we retain a ‘long-term memory’ of this world in which we lived. If we therefore consider stimulating such dormant memories through an emotional response, whereby the ‘unconscious’ memory becomes the ‘conscious’ act, through a re-engagement with nature, the potential to inspire the designer is endless.

Anthony Giddens (1984) presents a notion that we act as individuals within our environment, and such actions are driven largely by our ‘practical consciousness’. Giddens suggests that ‘all social systems, no matter how grand or far-flung, both express and are expressed in the routines of daily social life, mediating the physical and sensory properties of the human body’. (1984, 36) This theory suggests that we act as individuals in the world in an unconscious way through our ‘practical consciousness’ that has embedded a response within our memory. So if one thing happens we will respond in a particular way because that is how we have learned to respond to that situation or within that environment. Our response is triggered by temporal, social and spatial conditions, by knowledge that we have acquired through our interaction with the space in which we exist. If we take Giddens’ notion that our ‘conscious’ response has become the ‘unconscious’ act, we therefore need to achieve, through the design process, an ‘unconscious’ response to nature, through our ‘practical consciousness’.

Although Giddens ‘Theory of Structuration’ (1984) draws its hypothesis from social science this paper suggests that the ‘practical consciousness’ of the ‘new’ designer can and must be driven by the natural systems they interact with and the duality of ‘time’ and ‘space’ can be contextualised through an ecological avenue.

Arne Naess (2008, 81-82) suggests that ‘we cannot help but identify ourselves with all living beings’, but that we ‘largely ignore’ our ‘identification with nonhuman living beings’. This lack of affiliation between human life and nonhuman species became the subject of the project for the module. Students were tasked with choosing a ‘nonhuman’ species or organism that they would design a biodiversity shelter for, using a natural system, not necessarily related. Arne Naess's concept of 'ecological self' should be noted here, as it is the human relationship 'with other living beings' that provides the focus for the 'practical consciousness' that Giddens' relates to through the social interaction between human beings. Arne Naess suggests that 'the meaning of life, and the joy we experience in living, is enhanced through increased self-realisation'. We would like to suggest therefore that the designer must 'realise' the potential opportunity presented by co-creating with nature to inspire a new world, and that to achieve this there needs to be a deepening of the 'self' to become the 'new' design thinker.

The Ethical Dimension

A 'self-realisation' of our relationship with nature and the potential it has to inspire design however does not necessarily mean that the design outcome will be 'ethical'. To fully understand the relationship ethics has with the environmentally considered design outcome, we need to observe what we consider to be ethical. The reflexivity of the educator must be prevalent here as ethical dimensions lie within the values and principles of each and every one of us. But who is to assess the morality and ethical practice of every educator? This presented a grave dilemma, as it can be, and should be, a daunting prospect delivering a lecture on the ethics of design. We would argue it requires a further 'self-realisation' of the educator to fully understand that there is no right and wrong and that the ability of the individual to be ethical through their design practice will always be open to interpretation.

The duality of 'ethics' and the 'self' therefore requires further analysis. It is a controversial subject, that we align 'ethics' and the 'self' as a relationship, as it is based on an individual perspective of our 'self' within the world. As an individual we are influenced by the culture and beliefs of the society in which we have grown. We can therefore question whether our personal beliefs are based on an ethical foundation and ask who is to measure this phenomenon? We can suggest that critical reflection is key to the process, however we use reflexivity from a personal bias and therefore the process cannot be considered ethically challenged.

Naess (2008, p86) suggests that the 'concept of self-realization, as dependant upon insight into our own potentialities, makes it easy to see the possibilities of ignorance and misunderstanding in terms of what these potentialities are'. To deliver the complexities of this dilemma, two old German books, found in a recycling depot, were used. Although not ecologically related they illustrated a point. The first Die Flicht (The Duty) by Wilhelm von Scholz (1932), a renowned author held in high esteem, he signed his allegiance to Hitler in 1933 and published articles supporting the Nazi party policies. The second Hirtonnvelle by Ernst Wiechert (1935), again an author held in high esteem, he appealed to the students in Munich to retain their critical thinking and as the result of his public criticism of the imprisonment of Pastor Martin Niemöller by the Nazi party he was held in Buchenwald Concentration camp for seven weeks. (Klapper, J. 2009) Both men believed in the values and principles with which they lived. In hindsight we can now argue that Wilhelm von Scholz's beliefs were unethical, but what this serves to illustrate is that we as individuals can believe our morals to be ethical, however we must appreciate they are constituted by temporal, social and cultural dimensions that may promote unethical values. It is therefore essential that we adopt a reflexive process of self-evaluation where we constantly and critically reflect upon our principles and values, questioning whether they are moral, ethical and just.

The ethical principles by which we measure our actions requires a deep understanding of our 'self' and this can only be achieved by recognising our ability to be wrong. A constant self-critical evaluation of our principles must therefore be adopted by our 'self' as designer, to achieve meaningful and ethical design outcomes that can improve the quality of life for humankind, as well as protecting the planet and its biodiversity.

The Project

The project delivered to the students consisted of three parts. Part one asked that the students research the term 'shelter' in all its complexities, from the simple perspective of 'protection' from the elements, to a concept of 'home'. Choosing an animal/organism, they were asked to design a shelter that used biomimicry as the tool for their designs. They were also asked to consider the ethical dimension through the values and principles they believed to be crucial in achieving an ethical shelter that could protect and nurture its inhabitants. Using nature as a system for design inspiration the students chose organisms ranging from the domestic rabbit to pigeons and ants. Interestingly to choose the domestic rabbit provided complex and ethical issues relating to shelter. One student had observed a rabbit, allowed to roam free within an apartment, squeezing himself into a small space between the cooker and cupboard.

Considering this observation it was clear that the animal required a small space to enable him to feel secure within his environment. It was also clear that where we as humans design shelters for animals we tend to design them reflecting a human led structure and concept of home in mind. Consider the typical rabbit hutch designed to reflect a human home and the bird's nest adopting a shape that resembles our own home with the pitched roof. Using a natural system and emulating it through biomimicry to design an animal shelter presented the students with an interesting challenge. Figure one below shows conceptual sketches for a shelter for the domestic rabbit created by one of the student teams, whereby they used a shell as their inspiration for the structure and clay as the material.

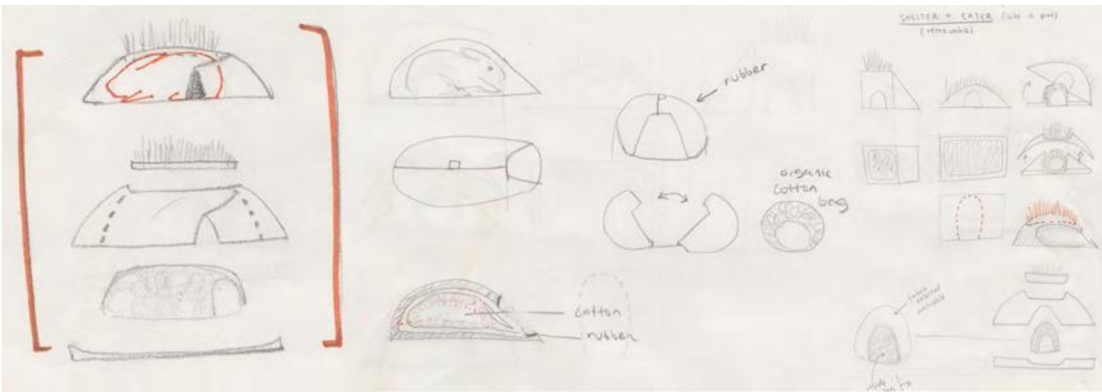


Figure 1 Concept designs for the Domestic Rabbit shelter

Another team decided to create a shelter that invited the Black Garden Ant to live within it, thereby preventing the problems of ants entering the human home. Details of materials were considered and investigated and a prototype produced influenced by the natural system of a garden ant.

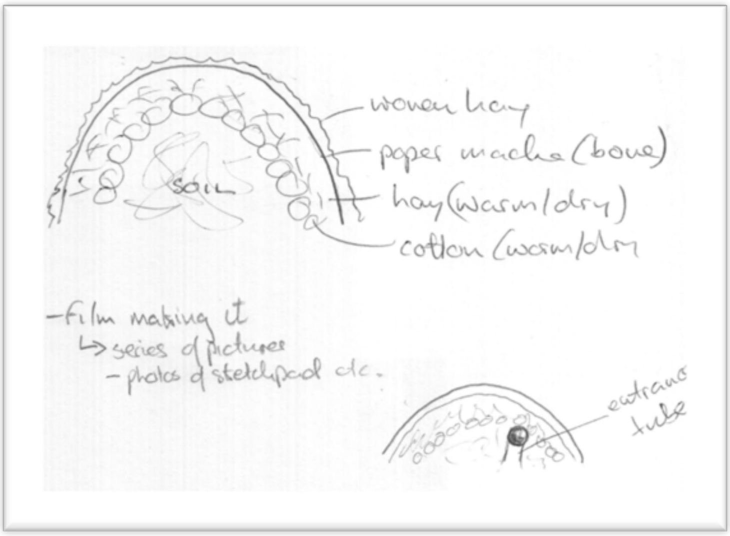


Figure 2 The Black Garden Ant // Conceptual development

Figure 3 - 8 The Black Garden Ant // Development of prototype

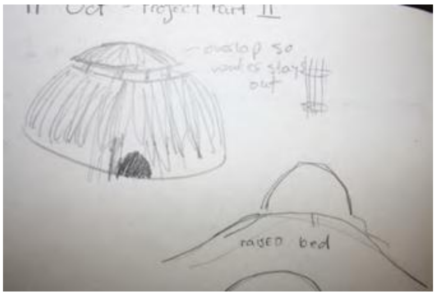
Thirdly, a wasp's nest was the inspiration for the design of an urban home for feral pigeons. Considered a pest to many cities, the students designed a home allowing them to live in a honeycomb structure, ensuring they retained their need to live in a community environment.

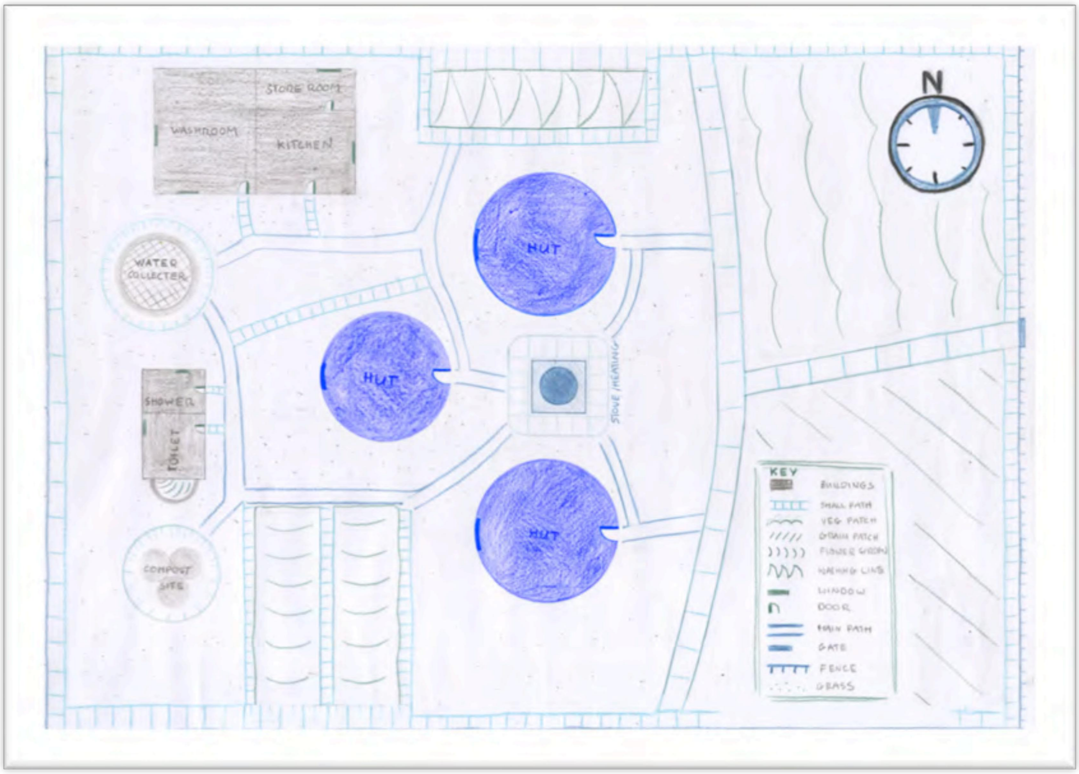
Figure 9 & 10 The Feral Pigeon, sketches and prototype

The design process, lectures and workshops combined to provide the students with an experience through which they engaged with nature at locations outwith their normal learning environment and conducive to their understanding of the influence nature can have on the conceptual development of their design.

Part 2 of the brief asked the students to then design a biodiversity human shelter, observing the natural system that they had already investigated for their organism. They were asked to be mindful of our 'needs' as a species and not our 'preferences'.

Group A, who had worked on the Black Garden Ant, explored homeless and displaced people across the planet, and their design utilised the building material and structure used to build their ant nest. The following images in Figures 11 – 15 show the development of their prototype and a plan of their proposed community.





Figures 11 – 15 Development of human shelter using materials and inspiration from Black Garden Ant shelter

Part 3 of this project combined theory and practice together asking the students to write an article titled 'How to Design a Human Shelter'. The students were asked to be critically reflective of their design process and their learning experience through their engagement with the module and its content. For the first six weeks of the project students had been given a paper or book chapter to read which was then discussed openly with the group each following week. This helped to embed the theory holistically with their creative practice, ensuring a deeper understanding of the module themes was achieved, allowing them to apply the theory to their design process. This proved to be a valuable aspect of the project helping and encouraging them to critically evaluate their own journey.

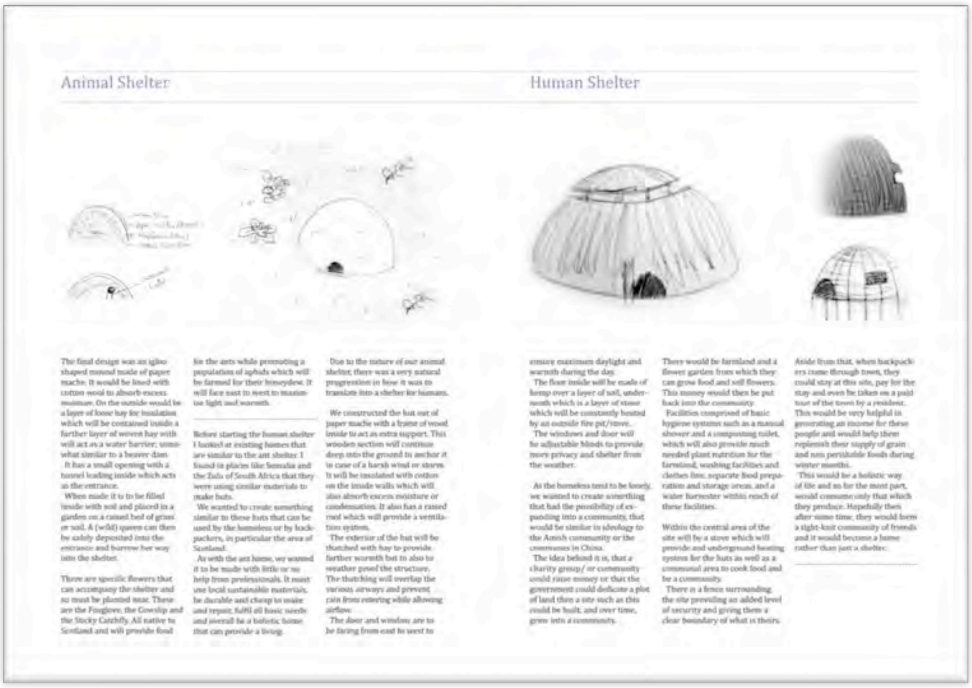


Figure 16 Student A Compares her Animal and Human Shelter

In her reflection student A suggested she had 'learned that being ethical is about more than just putting plastics and paper in the right bins and that what is needed is a greater conscious effort within all aspects of life in order to make a notable change'. In her closing statement she stated:

> 'Finally, one message I would give to people that I have found both insightful and enlightening, is that people have to realise that humans are a part of

> nature and not superior to it and to remember that nature is the reason we survive, without it we would be helpless.'

The Biophilia and Biomimicry Partnership

Orr (2004) suggests that we require 'ecological design intelligence' which is 'motivated by an ethical view of the world and our obligations to it'. To encourage this 'ecological design intelligence' Biophilia and Biomimicry became crucial concepts as drivers for design inspiration through this module. Janine Benyus (1997) suggests that we can make a 'conscious' decision to emulate 'life's genius'. However to engage with a natural system and mimic it through the design process requires an act of conscious awareness of that natural system and to achieve such a conscious recognition of such inspiration requires an understanding of nature and its potential. However this also assumes that we as a human species has respect for it's potential to inspire and that any design outcome therefore will be ethical. This is of course is not so.

Wilson (1984, 1) defines biophilia as 'the innate tendency to focus on life and lifelike processes' and suggests that 'a quiet passion burns, not for total control [of nature] but for the sensation of constant advance'. (1984, 10) Wilson goes on to suggest that the 'same knowledge that brought the dilemma to its climax contains the solution'. As a human species we have previously discussed our ability to be unaware of the impact of our actions in the wider sense. Our unconscious actions as Giddens (1984) suggests is driven by culture and social interaction and it is therefore necessary for us to become conscious of the potential of nature to inspire design. This requires a re-engagement of the human spirit with nature to nurture the connection of the unconscious response, to become the conscious act. As Edward O Wilson states, our 'crucial inadequacy is not likely to be remedied until we have a better grasp of the diversity of the life that created and sustains us' and 'it is a frontier literally at our fingertips, and the one for which our spirit appears to have been explicitly designed'. (1984, p20-21)

Using biophilic principles as the connector to re-engage the students with nature, four workshops delivered to the students that were crucial in promoting the values at the heart of Biophilia and Biomimicry. The first 'Biophilia: A way of engaging with nature' aimed to establish a reconnection of the human spirit with nature through emotional, cognitive, aesthetic and spiritual development. Locating the workshop within the University Botanical Gardens proved fruitful and it was the first step towards a 'mental development' through which the students could understand the relevance of co-creating with nature and consider an ethical dimension to their design practice.

The second workshop Biomimicry: Designing with Nature, aimed to identify Biomimicry as a tool, through which the designer can achieve an ecological design outcome. It was suggested, through the workshop, that by emulating living systems one could achieve ethical values inspiring design solutions. For this workshop the students were taken to the D'Arcy Thompson Zoology Museum where they were able to engage with a collection of animal artefacts exhibited within the University of Dundee. It is an inspirational space documenting the work of conservationist and biologist D'Arcy Wentworth Thompson who wrote his book On Growth and Form (1942) observing the relationship that mathematics has with nature. An inspiring environment in which to learn, the students were given tasks that encouraged them to recognise that emulating living systems added intrinsic ethical values to our culture.

Both workshops provided the necessary platforms through which nature could be seen and experienced by the students. The tasks were simple, quirky and fun but also profound in their explanation of fundamental aspects of designing through and with nature. Students achieved a 'self realisation' as we can see from the quotation from student A, whereby the potential of nature to inspire design can be ethically driven if the right tools are used. Biomimicry and biophilia as a partnership offered students an enhanced learning experience that will impact not only their design process and outcomes but also their relationship with nature through the deepening of their 'mental development' through 'self realisation'.

The Relevance of Resilience

The concept of 'resilience' in relation to ecological systems is a term that has been used widely by ecologists (Gunderson et al, 2009) to describe the ability of a 'system to recover to its former equilibrium state after disturbances'. The relevance for design is that 'resilience' can be a concept that is fundamentally at the heart of any design outcome. Holling (1973) suggested that 'resilience' as a concept would be used to describe the temporal transformations that can occur within an ecosystem. was key to this concept was the 'persistence of relationships within a system' and the 'ability of systems to absorb changes of state variables, driving variables and parameters, and still persist'.

The concept of resilience was promoted through a third workshop. We would suggest that for designers the concept of resilience is a greater challenge and yet one that should frame any investigative research within the design process. If we design with a historical bias we can clearly miss the fundamental requirements of the systems to change and adapt to new conditions. Design can play a crucial role in providing shelter that 'nurtures' and 'protects' humankind from the natural disasters that are becoming commonplace, through our changing climate.

Designing a biodiversity shelter for humankind means that the concept of 'resilience' becomes a crucial aspect of the design process. Delivering a workshop on this topic ensured students engaged with 'resilience', understanding its relationship with the key concepts of biomimicry and biophilia. What is important to note is that such concepts can be delivered independently of each other, however we would suggest that a more powerful tool for learning is achieved when all three concepts are complementing the concept of design through an understanding of ecology, what can be referred to as an 'ecotechnic' future. (Sanchez Ruano, 2013) To clarify this notion a fourth workshop was designed titled 'Symbiosis', where students examined the holistic experience for design where these three concepts compliment each other symbiotically. This brought a reflective perspective to the learning experience of the four workshops.

Evaluating the student experience

To evaluate the success or failure of the module 'Design Values, Issues and Ethics' we produced an online survey asking key questions relating to the learning experience. With 5 being very high and 1 being very low the students were asked to rate their experience and also give feedback in relation to the workshops and their effectiveness. What was important to assess was whether the learning experience would have a lasting effect on their design process and design intention for future projects. Ten out of fifteen students responded to the survey and all answers were rated 4 or 5 with only two responses to questions rated 3. Asked if the module had 'made [them] think differently about [their] own design practice' all respondents replied 'yes'. The students also now believed that they had acquired the 'tools' to 'become designers of a more sustainable and ethical future for biodiversity and human well-being'.

Some of the comments by the students communicated their understanding of their practice and the change that had occurred through their engagement with the module:

> 'This module has given me the background and confidence to question design decisions on their ethical grounds, be it on materials or production of waste, cost to the environment or the human cost.'

> 'I feel I now have a relevant perspective from which to begin to question the things we do, as individuals and as designers, to begin a change. One not of great challenges to fear, but one of great expectation on what nature can teach us, when we listen.'

> 'The workshops made me realise the importance of the environment.'

> 'It has been a great learning experience being on this module. It informed me of what I wanted to know about ethical and environmental design and beyond.'

> ‘I found the module Design Values, Issues and Ethics opened my eyes to ways I could make my own design more sustainable and ethical as well as sending a message about sustainable living. I have always been passionate about the environment but after this module I am even more so and want to strive to change our way of thinking towards our planet, through both my design and my personal life.’

We can observe from the student quotations that the module impacted not only on their design practice but also on their own lifestyle and the way in which they might engage with nature and society.

The Reflexivity of the Educator

What is a fundamental issue relating to the teaching of such concepts is our responsibility as educators to be reflexive and to constantly challenge not only the students but our ‘self’. This project was not merely a partnership of ecological tools driven through an engagement with nature, but also of two educators, one from a graphic design background and one from industrial design. Although from very different disciplines we married our specialist skills and vision to enhance the student learning experience. It was a partnership built on trust and like-mindedness, with a desire and passion to use design as a tool to facilitate ecological and societal change.

We can never be hasty in our endeavour to promote such issues without critically reflecting on our own practice and vision and question our own ability to be ethical and environmentally visionary. It is about accepting our failures in life and acknowledging that through failure can come enlightenment. We can attempt to make change in small steps and through the constant analysis of such steps we may contribute to a healthier planet and a population that begins to examine the impact of their interaction with society and the natural world.

Our most powerful tool is reflexivity. Through a ‘transparent reflexivity’ we become more ‘visible and open to debate’. (Rose, 1997) As educators, what we do with our findings and conclusions will determine whether we are successful in our quest for a world that embraces empathy and compassion as fundamental qualities towards an ethical society.

Conclusion

We set out to examine contemporary design values, issues and ethics through biomimicry, biophilia and resilience, exploring conceptual opportunities through an ecologically driven design project. We have also suggested that the student's engagement with nature has the potential to inspire design. Using a partnership of biomimicry and biophilia to provide the designer with an understanding and knowledge of nature, enhancing their awareness of the conscious and unconscious response to the natural environment, deepened their design process and, we have argued, their 'self-realisation'. Through our unconscious response to nature we have discussed the impact this can have on our conscious act through our 'practical consciousness'. (Giddens, A 1984)

As a new module delivered to design students, 'Design Values, Issues and Ethics' aimed to promote a set of principles for design that were environmentally and ethically driven, providing a platform on which we could 'foster intelligence, thought, and good heart'. (Orr 2004, xiv) Through the four workshops delivered to the students we promoted a relationship that nurtured a journey of design, and through evaluation of the module, it appears to have provided students with a new vision for a more ecologically driven design process. Using biomimicry, biophilia and resilience as tools for design has proven itself to be a valuable relationship and one that offers an avenue to Orr's 'ecological design intelligence'.

For the educator the lesson is not so simple. Through constant re-evaluation and reflexivity we need to examine our 'self' and our own individual ethical intention. To encourage new ways of seeing design, holistically aligning itself with nature, we need to 'come home'. (Orr 2004, 202) As Orr suggests we must prepare young people to 'restore ecological and human scale to a civilisation that has lost its sense of proportion and purpose'. Preparing our students to understand the complexities of designing through ecological and ethical principles means we need them to question what they are designing, whom they are designing for and what is their design intent.

Only then can we begin to achieve a truly holistic view of design and its potential to change.

Acknowledgements

We would like to thank Professor Seaton Baxter and the Centre for the Study of Natural Design for his continued support in our endeavour to bring ecological thinking to the undergraduate design programmes.

List of Figures

Figure 1	Concept designs for the Domestic Rabbit shelter
Figure 2	The Black Garden Ant // Conceptual development
Figure 3 - 8	The Black Garden Ant // Development of prototype
Figure 9 - 10	The Feral Pigeon, sketches and prototype
Figures 11 – 15	Development of human shelter using materials and inspiration from Black Garden Ant shelter
Figure 16	Student A Compares her Animal and Human Shelter

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Using nature to inspire Design Values, Issues & Ethics.

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Abstract:
Exploring contemporary design values, issues and ethics was the purpose of a new module delivered to design students at Duncan of Jordanstone College of Art & Design as the University of Dundee, Scotland. Using Biophilia, Biomimicry and Resilience as themes for design thinking, was crucial in establishing a framework, to explore the potential for these themes to embrace natural systems thinking and inspire conceptual opportunities. This required each student to shed any preconceived ideas about potential design outcomes and experience a deepening their 'self'. David Orr suggests that it requires us to 'come home' (Orr, A 2004).

This empirical study is a reflection of these key themes, using a synergistic methodology, brought together through a symbiotic view of participation through and with nature and design. The impact of this experience for the student, and for design, is evaluated and discussed within this paper.

This abstract includes 143 words.

***Keywords**: Biomimicry, Biophilia, Resilience, Design*

Introduction

The reflexivity of the design educator is crucial in promoting a learning environment that encourages the exploration of one's ethical and environmental values within a contemporary context. To explore the learning environment for design we need to reflect on our past failures as designers and realise that we live in a society that is driven by negative economic forces rather than positive environmental ones. David Orr (2004, p.xii-xiii) on questioning our education system asks, 'How do we teach [our students] to love land and community when our society values such things far less than it does individualism and consumption?' Orr suggests we are 'failing to equip them to deal with the consequences of what we are leaving behind'.

Given an opportunity to create a new module 'Design Values, Issues and Ethics', it provided the potential for design education to embrace a new set of principles that promoted an environmentally and ethically driven design process. Using the UN Decade of Education for Sustainable Development 2005-2014 strategic goals for 'reforming education', and the Higher Education Academy recommendations (2009) for sustainable development within Higher Education Institutions, this module set out to explore the potential of Biophilia and Biomimicry to inspire design, and through this activity we have conducted an empirical study of the work and learning experience of participants who engaged with this new module.

Recognising the value of design in improving the quality of life for humankind, and the need for students to become aware of the relevance of environmental issues and ethical values as an important aspect of their creative practice, the module has promoted a holistic approach to theory and practice, enhancing the learning experience for students and promoting reflexivity as an embedded process for design.

This paper presents the results of this empirical study and provides an analysis of the data collected through the work produced by the students, reflection articles and an evaluation of the module and its contents, highlighting some statements provided by students.

What did we want to know?

Design Values, Issues and Ethics is an optional, expansive module, offered to level three undergraduate degree students within Duncan of Jordanstone College of Art & Design at the University of Dundee, Scotland. The module is delivered to students from a range of subjects such as jewellery & silversmithing, illustration, product design, interior and environmental design, textiles, animation, graphic design and fine art. With such a diverse range of disciplines, a conscious decision was made to use biomimicry as the driver for a practical project, bringing an ecological lens to the design process. Marrying this with biophilia gave the process a unique view of nature as it inspired not only the project, but also the learning experience of the student.

The aim of this study was to examine the way in which nature can be a catalyst for design inspiration. This led us to consider the research questions we were asking and consider what it was we wanted to know. Using a new design process model REASON, we were asking whether giving emphasis to the 'Nexus' through reflexivity would facilitate a sense of 'self realisation' (Naess, p.81-82) within the student, enabling a deeper understanding of design values, issues and ethics.

Using nature as inspiration for design, promoted the environmental issues we felt were important for a designer in the 21st century, and through a duality of biomimicry and biophilia, we set out to examine how such concepts can influence and inspire the design process, promoting a more ethical perspective of creative practice.

A Symbiotic Methodology

As stated previously, Design Values, Issues and Ethics is an optional, expansive interdisciplinary module, offered to level three undergraduate degree students within Duncan of Jordanstone College of Art & Design (DJCAD) at the University of Dundee, Scotland. To encourage a closer connection to nature, the module was delivered at the University's Botanic Gardens. This became important when delivering the workshops and related activity.

The module is now in its third year and this empirical study utilises data collected from participants over a three-year period, from September 2012 to December 2014. This has involved 63 students over the 3 years, 15 in year 1, 25 in year 2 and 23 in year 3. The research was designed to examine the ability of biomimicry and biophilia to inspire an ecologically driven design output, through a practical, brief driven project, combined with a theoretically driven written submission promoting the reflexivity of the 'Self' (Naess, p.81-82).

The key themes of biomimicry, biophilia, resilence and symbiosis were introduced through four workshops, delivered by David Sanchez. David is currently a PhD student at DJCAD, and his thesis focuses on biomimicry. David was invited to use the module to conduct research for his PhD and he developed the four workshops to gather data. His input was crucial in promoting a research led teaching philosophy for the module. The workshops will be discussed in more detail later in this paper.

The project, in year one, was refined and changed for year two to accommodate a wider range of design disciplines. Therefore, the data gathered in year's 2 & 3 have provided a deeper level of understanding of the project submissions. The written articles however, have remained the same and have drawn on theory presented over the first 5 weeks through specific book chapters that were aligned with the topics delivered in each session. Three levels of data were collected: the practical project submissions, the reflection articles, and an evaluation of the module and workshops.

We invited two visiting lecturers to contribute to the module. Now in its third year, the module has evolved to embrace ecology and ethics, through a biological lens, by inviting Dr Keith Skene, a world renowned biologist to work with the students, deepening their research and understanding of ecology. Professor Seaton Baxter who, as founder of the Centre for the Study of Natural Design, was invited to contribute insights into the role of indigenous wisdom, to enhance the students understanding of a 'moral community' (Holt, 2015, p.xi).

The Synergistic Workshops

To deliver the themes of the module, biophilia, biomimicry, resilience and symbiosis, workshops were developed by David Sanchez to engage the students with nature, helping them to understand the complexity of each subject. Orr (2004, p.2) suggests that we require 'ecological design intelligence' which is 'motivated by an ethical view of the world and our obligations to it'. To encourage this 'ecological design intelligence' biophilia and biomimicry became crucial concepts as drivers for design inspiration through this module. Janine Benyus (1997, p.2) suggests that we can make a 'conscious' decision to emulate 'life's genius'. However, to engage with a natural system and mimic it through a creative process requires a conscious awareness of and understanding of nature and its potential to inspire design. This however, assumes that we, as a human species hold a respect for nature's potential to inspire, and that any design outcome therefore will be ethical. This of course is not so.

Wilson (1984, p.1) defines biophilia as 'the innate tendency to focus on life and lifelike processes' and suggests that 'a quiet passion burns, not for total control [of nature] but for the sensation of constant advance' (1984, p.10). Wilson goes on to suggest that the 'same knowledge that brought the dilemma to its climax contains the solution'. As a human species we are unaware of the impact of our actions. Our 'unconscious' actions, as Anthony Giddens (1984) suggests, is driven by culture and social interaction, and it is therefore necessary for us to become 'conscious' of the potential of nature to inspire design. This requires a re-engagement of the human spirit with nature, to nurture the connection of the unconscious response, to become the conscious act. As Edward O Wilson states, our 'crucial inadequacy is not likely to be remedied until we have a better grasp of the diversity of the life that created and sustains us' and 'it is a frontier literally at our fingertips, and the one for which our spirit appears to have been explicitly designed'. (1984, p.20-21)

Biophilia: Engaging with Nature

This workshop aimed to establish a reconnection of the human spirit with nature through emotional, cognitive, aesthetic and spiritual development. Locating the workshop within the University Botanical Gardens proved fruitful and it was the first step towards a 'mental development' through which the students could understand the relevance of co-creating with nature and consider an ethical dimension to their design practice.

Students were taken into the grounds of the Botanic Gardens and, in a circle, used their senses to hear, see and feel nature. Whilst this might seem very ordinary, students experienced very different sensations when, working in pairs, one was blindfolded and taken around the gardens to touch plants and trees. This activity stimulated the 'unconscious' response we recognise as the first step to engaging with nature.

Figure 1 & 2 Biophilia workshop

Biomimicry: Designing with Nature

The Biomimicry workshop aimed to identify Biomimicry as a tool, through which the designer could achieve an ecological design outcome. It was suggested, through the workshop, that by emulating living systems, one could achieve ethical values, inspiring design solutions. Observing their natural environment within the grounds of the Botanic Gardens encouraged activities that were conducive to their project. An inspiring environment in which to learn, the students were given tasks that encouraged them to recognise that emulating living systems added intrinsic ethical values to our culture. Students were required to choose an animal and mimic it in some way. Although a fun exercise it promoted the value of a non-human species.

Resilience: Change with Nature

The theme of 'resilience' in relation to ecological systems is a term that has been used widely by ecologists (Gunderson, 2009) to describe the ability of a 'system to recover to its former equilibrium state after disturbances'. The relevance for design is that 'resilience' can be a concept that is fundamentally at the heart of any design outcome. Holling (1973) suggested that 'resilience' as a concept would be used to describe the temporal transformations that can occur within an ecosystem. What was key to this concept was the 'persistence of relationships within a system' and the 'ability of systems to absorb changes of state variables, driving variables and parameters, and still persist'.

The Resilience workshop promoted an emotional and conscious response to nature and how it can change. Students were asked to gather materials from the gardens to build an island. They were split into two groups and began to immerse themselves in the activity. They were given words relating to nature, such as 'river', 'mushroom', 'wheat', 'pine', to place strategically within their island. The students then named their island and they were then given artificial things to include, such as plastic straws, post its and pegs. Once they had taken pride in their creation, the groups switched and were tasked with destroying the other team's island.

It became obvious the students had become emotionally attached to 'their' island, and were uncomfortable with the concept that they would destroy something the other team had spent time building. The words used by the students to describe their emotions were, 'sad, disappointed, not fair and guilty'. The students then went back to their island and rebuilt it. This then gave them a sense of hope that they could rebuild their island but make it better.

Figure 3 Resilience: Building an island

We would suggest that for designers the concept of resilience is a greater challenge and yet one that should frame any investigative research within the design process. If we design with a historical bias we can clearly miss the fundamental requirements of the systems to change and adapt to new conditions. Design can play a crucial role in providing communities that 'nurture' and 'protect' humankind from the natural disasters that are becoming commonplace, through our changing climate.

Symbiosis: Transcend with Nature

The final theme was where students examined the holistic experience for design through understanding the value of biophilia, biomimicry and resilience to compliment each other and generate a symbiotic relationship with the living planet through design. In this context, the meaning of symbiosis is referred to as the benefit of a mutual relationship between two or more different entities, in this case the designer's intention and earth's sustainability. This brought a reflective perspective to the learning experience of the four workshops.

The Design Process

The module initially used the design process framework **REASON**: **Research // Environmental Evaluation // Analysis // Selection // Outcome // Nexus** (Malcolm, J 2010) which places environmental evaluation within the research phase of the design process and gives credence to reflective practice as the link between the learning experience from one project, to its application on the next through 'nexus'. This provided a platform through which key principles were driven. The REASON framework was then complemented, in year 3, with a Symbiotic Design Practice Helix (Figure 4), which interconnects the concepts of biophilia, biomimicry and resilience in order to design ethically. Such concepts were intended to reconnect, rediscover and reflect, on the design process through the learning journey. This framework is based on 'integral theory' (Wilber, K. 2001) and serves as a guide for the educator when encouraging awareness, understanding and action, as well as establishing a legacy beyond the module.

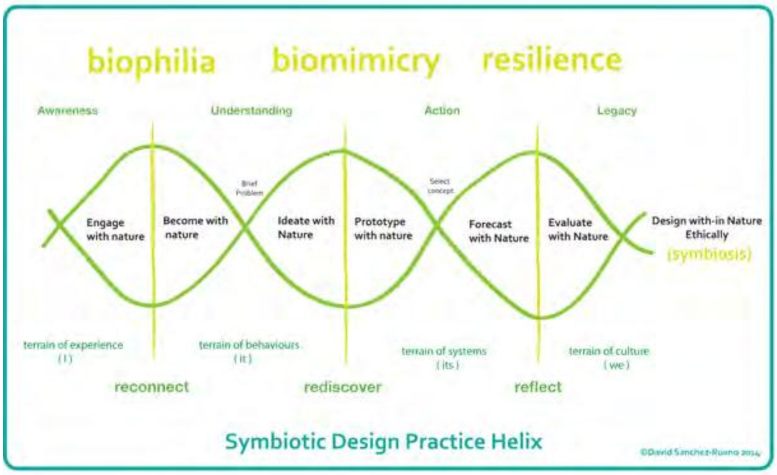

Figure 4 Symbiotic Design Practice Helix

7

To understand and realise the true potential of design within our world we need to acquire 'an affinity for life, earth, forests, water, soils and place – what E. O. Wilson calls Biophilia' (Orr, 2004, p.129). This reference by David Orr to Edward O Wilson's concept of biophilia is particularly relevant to this discussion. Wilson (1984, p.1) suggests that 'to explore and affiliate with life is a deep and complicated process in mental development'. He also suggests we need a new way of 'looking at the world' (Wilson, 1984, p2) that allows us to embrace our 'instinct' as a human species, thereby placing a 'greater value on [other organisms], and on ourselves'. If we consider that the use of our 'long-term memory' (Wilson, 1984, p.41) through our interaction with nature could influence our 'short-term memory', what learning experience can be achieved?

Moving from the 'unconscious' to the 'conscious'

Adopting biophilic, biomimetic and resilience principles to influence and inspire design presented the project with an interesting complexity. To understand fully the relationship, it is important we consider the way in which our conscious and unconscious responses to nature and design can act. As Wilson has noted, the 'long-term memory' can influence the 'short-term memory', and for this purpose we would suggest that there is a relationship between the unconscious 'long-term memory' and the conscious 'short-term memory'. As children we engage with nature through acts of play, discovering a slug under a stone, or a spider crawling up a wall. We are not conscious of the influence of such interactions, but we retain a 'long-term memory' of this world in which we lived. If we therefore consider stimulating such dormant memories through an emotional response, whereby the 'unconscious' memory becomes the 'conscious' act, through a re-engagement with nature, the potential to inspire the designer is endless.

Anthony Giddens (1984) presents a notion that we act as individuals within our environment, and such actions are driven largely by our 'practical consciousness'. Giddens suggests that 'all social systems, no matter how grand or far-flung, both express and are expressed in the routines of daily social life, mediating the physical and sensory properties of the human body'. (1984, p.36) This theory suggests that we act as individuals in the world, in an unconscious way, through our 'practical consciousness', embedding a response within our memory. It is therefore inevitable that if one thing happens we will respond in a particular way, because that is how we have learned to respond to that situation or within that environment. Our response is triggered by temporal, social and spatial conditions, by knowledge that we have acquired through our interaction with the space in which we exist. If we take Giddens' notion that our 'conscious' response has become the 'unconscious' act, we therefore need to achieve, through the design process, an 'unconscious' response to nature, through our 'practical consciousness'. Figure 5 below illustrates the fluidity through which our 'unconscious' response to nature becomes the conscious act, thereby inspiring design through our 'practical consciousness'.

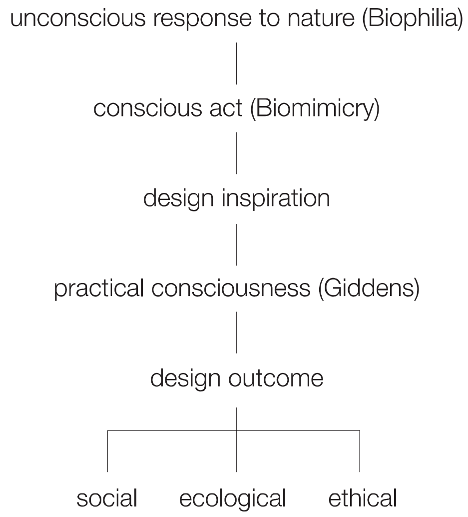

Figure 5 The unconscious response to nature

Although Giddens 'Theory of Structuration' (1984) draws its hypothesis from social science, this paper suggests that the 'practical consciousness' of the 'new' ethical designer can and must be driven by the natural systems they interact with, and the duality of 'time' and 'space' can be contextualised through an ecological avenue.

Arne Naess (2008, p.81-82) suggests that 'we cannot help but identify ourselves with all living beings', but that we 'largely ignore' our 'identification with nonhuman living beings'. Arne Naess's concept of 'ecological self' should be noted here, as it is the human relationship 'with other living beings' that provides the focus for the 'practical consciousness' that Giddens' relates to. Naess however, suggests that 'the meaning of life, and the joy we experience in living, is enhanced through increased self-realisation'. We would like to suggest therefore that the designer must 'realise' the potential opportunity presented by co-creating with nature to inspire a new world, and that to achieve this there needs to be a deepening of the 'Self' to become the 'new' design thinker.

The Ethical Dimension

A 'Self-realisation' of our relationship with nature and the potential it has to inspire design however does not necessarily mean that the design outcome will be 'ethical'. To fully understand the relationship ethics has with the environmentally considered design outcome, we need to observe what we consider to be ethical. The reflexivity of the educator must be prevalent here, as ethical dimensions lie within the values and principles of each and every one of us. But who is to assess the morality and ethical practice of every educator? This presented a grave dilemma, as it can be, and should be, a daunting prospect delivering a lecture on ethics. We would argue it requires a further 'self-realisation' of the educator to fully understand that there is no right and wrong and that the ability of the individual to be ethical, through their design practice, is always open to interpretation. What we must always remember is that ethics is a human-centred concept.

The duality of 'ethics' and the 'self' therefore requires further analysis. It is a controversial subject, that we align 'ethics' and the 'self' as a relationship, as it is based on an individualistic perspective of our 'self' within the world and promotes an egocentric vision. As individuals, we are influenced by the culture and beliefs of the society in which we have grown. We can therefore question whether our personal beliefs are based on an ethical foundation and ask who is to measure this phenomenon? We would suggest that critical reflection is key to the process, however we use reflexivity from a personal bias and therefore the process cannot be considered ethically challenged.

We cannot claim to be able to teach ethics, but rather to deepen the critical thinking of students to facilitate a move towards 'Self-realisation'. John Nolt (2015, p.160) suggests 'ethical biocentrism is the view that all living things are morally considerable'. Nolt (2015, p.163) discusses Naess's belief in the 'Self', where we are required to have compassion for other non-human species. There is a significance attached to the capital 'S' where is becomes the 'expanded version' of the 'self' where it suggests a more egocentric and individualistic act. The ethical principles by which we measure our actions therefore requires a deep understanding of our 'Self' and this can only be achieved by recognising our ability to be wrong.

Evaluating the Student Experience

As stated earlier, the evaluation of the student experience drew data from three sources, the practical group submission, a reflective written article and the module evaluation. John Nolt (2015, p.xi) discusses the concept of the 'moral community' and suggests it is related to 'those whose welfare we hold to be morally considerable' and that ethics was originally the domain of 'tribal' communities. The sense of belonging to a 'community' or 'tribe' means ethical decisions are culturally driven, hence the problems the planet faces, arising from bad moral judgements by communities.

It is this 'moral community' the students were asked to consider in their 'Design of a Community'. The 'community' was sub divided into Housing, Water, Food, Communication, Education, Transportation and Health. Each group then chose a topic at random, pulled from a hat. They were also asked to consider the ethical dimension through the values and principles they believed to be crucial in achieving an ethical community that could protect and nurture its inhabitants.

The Practical Project

Evaluating the project itself raised an interesting point where the design brief challenged the students to consider what they believe a design outcome should be. The following statement by a student highlights this point:

> 'This course has been challenging in parts. For some time near the beginning of the project I found it difficult being unsure of exactly what I was working towards as a final outcome. In the learning model that I am used to it is generally made very clear.
>
> However, I think that I actually learnt more because of this uncertainty. Because I was not always researching with a specific goal in mind I was able to explore and experience outside of what I thought I 'should' be learning. I was not just absorbing facts so that I could hand them back in the form of an assignment, but making discoveries that actually made me consider how, as a designer, I could bring about change.'

This reflective statement suggests that as educators, the way in which we deliver projects can affect the way in which students will learn. The written brief, therefore, is crucial in facilitating the learning experience to become expansive, promoting an understanding of the complexities of designing for a community, whilst acknowledging there is a role for the designer whose desire it is to nurture change.

Through the project submissions, we were able to observe the transformation of design thinking, where it moved from a single vision lens, to a complex symbiotic vision, incorporating multiple facets for a new society. Research into specific organisms, both animal and plant, became more rigorous, particularly through the contribution of Dr Keith Skene.

The resulting designs varied in complexity, allowing us to observe the impact nature can have on design and the creative process. This is illustrated in Figure 6 below.

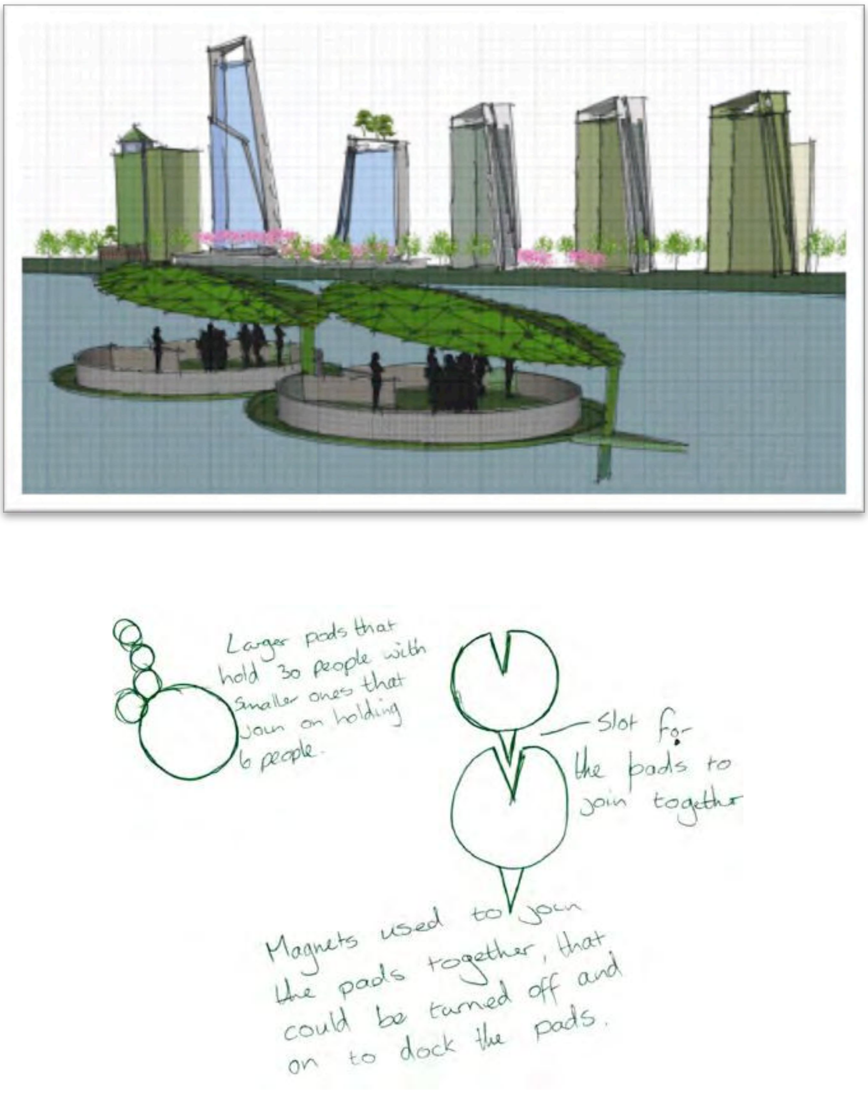

Figure 6 Design for Transportation mimicking the Giant Lily Pad and Pond Skater

12

Designing 'Health' for a community however, was far more complex and required an understanding of systems thinking within an ecological context. Dr keith Skene promoted this aspect through his concept of 'sub-optimality in nature' (Skene, 2011, p.378). To understand how organisms function and interact together to ensure the sustainability of each species, was crucial in understanding how the health of a community could be examined or indeed improved. Figure 7 illustrates the complexity of working with multiple organisms to design a system aiding the health of an individual and their environment. Taking inspiration from the Leaf Cutter Ant, the Glass Frog and the Hummingbird, students proposed a way in which we can become more observant regarding the emotional and physical changes within our own body. They promoted a system based on nutrition, health and recycling, important dimensions of well-being.

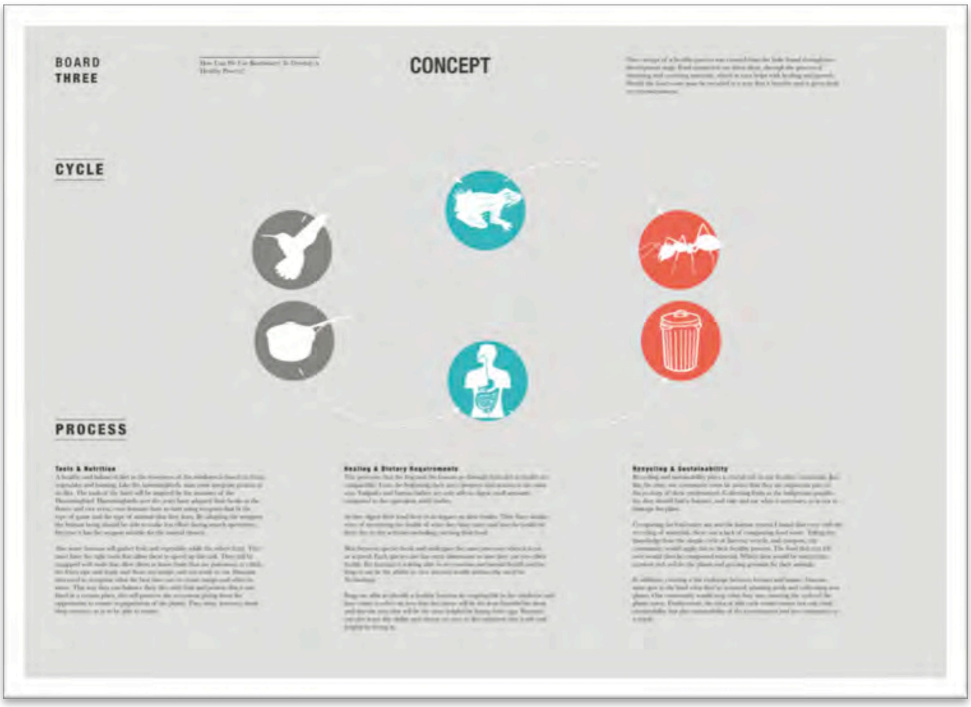

Figure 7 Health

Being able to visualise a system, which does not already exist, can be challenging and at times students did struggle. To overcome this they were given a short activity on drawing, using a Goethian method of scientific observation. To draw using the imagination required them to lose any preconceived intentions where visualisation is not copying, but rather creative, from one's own imagination and experience. The activity gave students an opportunity to draw and enjoy the surroundings of the Botanic Gardens, not initially realising the relevance of the method to help them visualise a concept. This was reinforced when they began visualising their ideas.

The Written Article

The 'nexus' within the design process invited the students to be reflexive through critical thinking. In this case the format used was a written article in which they discussed their process and reflected on their learning journey. A learning map, outlining their design process, complemented the article. Both the written article and learning map were individual submissions. Through these submissions they could reflect on team activity and what their contribution had been.

The importance of this process is to holistically marry theory and practice together, aligning it with their creative practice. The articles also allow us, as facilitators of the module, to evaluate the individual learning journey and ascertain whether the student achieved a sense of 'self-realisation'. The following quotations from the students suggest this process was successful and whilst students recognised the complexity of the themes, they also recognised the principles they presented. As one student suggested 'it was a light bulb moment'.

Figure 8 An example of a reflection article

In her reflection one student suggested she had 'learned that being ethical is about more than just putting plastics and paper in the right bins and that what is needed is a greater conscious effort within all aspects of life in order to make a notable change'. In her closing statement she added:

> Finally, one message I would give to people that I have found both insightful and enlightening, is that people have to realise that humans are a part of nature and not superior to it and to remember that nature is the reason we survive.

What is important to note is the recognition given by students to the role Dr Keith Skene and Professor Seaton Baxter played in deepening their understanding of natural systems and indigenous wisdom. To use biology to complement design was extremely successful and enhanced the students' knowledge of nature and its potential to inspire design.

Module Evaluation

To evaluate the success or failure of the module 'Design Values, Issues and Ethics' we produced a quantitative online survey, in year 1 and 2, including both open and closed questions, relating to the learning experience. In year 3 the school evaluated the module through a formal quantitative survey, aligning the questions with the National Student Survey (NSS), where again both open and closed questions were included. In this evaluation we draw on results from both surveys.

In year 2 we received 7 of a possible 25 responses. With 5 being very high and 1 being very low, the respondents in year 2 were asked to rate their experience of the module and the workshops in terms of their effectiveness. When asked 'how they would rate their learning experience' all respondents awarded the module an overall 5. When referring to the workshops all respondents rated them either 4 or 5. Student's suggested the workshops created 'a sense of curiosity and discovery (enchantment with the natural world)' and an 'awareness of what you are going to leave for future generations and our world'. They believed they had achieved a 'new way to see and act in the world [in which they] live'. They also recognized they had gained 'a sense of reconciliation between human intention and nature's purpose'.

The NSS survey in year 3, received 8 of a possible 23 responses. The questions gave two options for answers, which was 'agree' or 'disagree'. When asked if 'the module aims were clear' 7 out of 8 agreed, commenting that they 'liked the fact that tutors didn't tell us exactly what [the] final community designs should be as it allowed each group to go down their own roots without worrying if it would be right'. Another respondent suggested the module had 'change[d their] perspective about design' and how they 'as designers' could have 'direct impact in the world'. They did however acknowledge the complexity of the module and stated they knew what was 'needed to be submitted' for the module, and what they would 'get out of' it, but that 'how to get there wasn't so clear'. They then go on to explain that they [thought] it 'benefited [them] as it encouraged [them] to be much more creative with [their] thinking'. All responses were very positive and students also commented on the location in which they were learning, stating they 'enjoyed working at the Botanic Gardens'.

What was also important to assess was whether the learning experience would have longevity in relation to their design intention for future projects. Asked if the module had 'made [them] think differently about [their] own design practice' all respondents replied 'yes'. The students also now believed that they had acquired the 'tools' to 'become designers of a more sustainable and ethical future for biodiversity and human well-being'. Students suggested that the module 'would help them with their design projects' and that it helped 'broaden their perspective on ethics'. They also expressed a desire to 'explore biophilia, biomimicry, resilience and symbiosis through further studies'. Five out of eight students also claimed it would help them with their final research thesis.

Reflecting on the aims of this empirical study and the research questions we set out to explore, we can observe that whilst the themes promoted through the module were complex and multidimensional, through an ethically driven vision, students embraced nature and achieved a profoundly inspired learning experience.

The Reflexivity of the Educator

What is fundamental to the teaching of such concepts is our responsibility as educators to be reflexive and to constantly challenge not only the students, but our 'Self'. This project was not merely a partnership of ecological themes driven through an engagement with nature, but also of two educators, one from a graphic design background and one from industrial design. Although from very different disciplines we married our specialist skills and vision to enhance the student learning experience. It was a partnership built on trust and like-mindedness, with a desire and passion to use design as a tool to facilitate ecological and societal change.

We can never be hasty in our endeavour to promote such issues without critically reflecting on our own practice, and question our own ability to be ethical and environmentally visionary. It is about accepting our failures in life and acknowledging that through failure can come enlightenment. We can attempt to make change in small steps and through the constant analysis of such steps we may contribute to a healthier planet and a population that begins to examine the impact of their interaction with society and the natural world.

Our most powerful tool is reflexivity. Through a 'transparent reflexivity' we become more 'visible and open to debate' (Rose, 1997). As educators, what we do with our findings and conclusions will determine whether we are successful in our quest for a world that embraces empathy and compassion as fundamental qualities towards an ethical society.

Conclusion

Within this empirical study we set out to examine contemporary design values, issues and ethics through biomimicry, biophilia and resilience, exploring conceptual opportunities through an ecologically driven design project. We have also suggested that the student's engagement with nature has the potential to inspire design. Using a partnership of biomimicry and biophilia to provide the designer with an understanding and knowledge of nature, enhancing their awareness of the conscious and unconscious response to the natural environment, deepened their design process and, we have argued, their 'self-realisation'. Through our unconscious response to nature we have discussed the impact this can have on our conscious act through our 'practical consciousness' (Giddens, 1984).

As a new module delivered to design students, 'Design Values, Issues and Ethics' aimed to promote a set of principles for design that were environmentally and ethically driven, providing a platform on which we could 'foster intelligence, thought, and good heart' (Orr, 2004, p.xiv). Through the delivery of four themed workshops, we promoted a relationship that nurtured a journey of design, and through evaluation of the project, written article and module, it appears that students have now been equipped with a new vision for an ecologically and ethically driven design process. Using biomimicry, biophilia and resilience as tools for design has proven itself to be a valuable relationship and one that offers an avenue to promote Orr's 'ecological design intelligence'. The module won an award for innovation (2014) from the University of Dundee.

For the educator the lesson is not so simple. Through constant re-evaluation and reflexivity we need to examine our 'Self' and our own individual ethical intention. To encourage new ways of seeing design, holistically aligning itself with nature, we need to 'come home' (Orr, 2004, p.202). As Orr suggests we must prepare young people to 'restore ecological and human scale to a civilisation that has lost its sense of proportion and purpose'. Preparing our students to understand the complexities of designing through ecological and ethical principles means we need them to question what they are designing, whom they are designing for and what is their design intent. Only then can we begin to achieve a truly holistic view of design and its potential to nurture change.

Acknowledgements: *We would like to acknowledge the valuable contribution Dr Keith Skene and Professor Seaton Baxter have made to this module. They have both generously given their time and expertise, and encouraged the development of an ecological design philosophy through their support of this module.*

List of Figures

Figure 1 & 2	Biophilia workshop
Figure 3	Resilience workshop: Building an island
Figure 4	Symbiotic Design Practice Helix
Figure 5	The unconscious response to nature
Figure 6	Figure 6 Design for Transportation mimicking the Giant Lily Pad and Pond Skater
Figure 7	Health
Figure 8	An example of a reflection article

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Appendix A.2

UNIVERSITY OF DUNDEE

CASE

College of Art, Science & Engineering

Learning & Teaching Awards 2014

Joint Winner

Jackie Malcolm & David Sanchez

Duncan of Jordanstone College of Art & Design

Stephen Decent
....

Professor Stephen Decent

Vice Principal and Head of College, College of Art, Science and Engineering

Date 24.3.14

Appendix A.3. Module Description

UNIVERSITY OF DUNDEE

DUNCAN OF JORDANSTONE COLLEGE OF ART AND DESIGN

MODULE GUIDE

Module Code **DJ31014**	**Title:** **Design Values, Issues & Ethics**	**Credit Rating** 30 Credits
Module Leader / Tutors	Jackie Malcolm j.y.malcolm@dundee.ac.uk	
Description of the module and Aims	Design values, issues and ethics will be critically investigated through an interdisciplinary group project using a design process framework. This module introduces the 'bigger picture' for design activity and its intervention for 21st century creative practice. It will promote environmental design values, issues and ethics as an enhancement of student learning, empowering you to participate and act through design outcomes both visual and written. Consumer culture, market driven economies and issue driven agendas will be explored in relation to design values, issues and ethics, promoting an individual philosophy within a changing environment. This module will complement your design discipline allowing you to investigate a deeper level of awareness of creativity. **Aims:** To promote an awareness of the role of design values, issues and ethics within the context of 21st century design. To introduce the tools and techniques to enable participation in a sustainable and ethical design practice and reflect upon the design process. To promote the investigation of emerging activity where design thinkers are agents for change, to sustain and maintain human well-being. To introduce design values and ethical issues through creative practice. **Knowledge and understanding:** • Develop a knowledge and understanding of ethical issues within the context of design practice. • Develop an appreciation of the value of design within society. • Develop an understanding of interdisciplinary design practice. • Develop an understanding and knowledge of eco-literacy. **Skills:** • Using a design process framework we will develop the tools and techniques to explore design values, environmental issues and ethics within creative practice. • Cultivate design research practice • Cultivate articulation/communications skills, both verbal and visual,	

	responding to the complexities of design issues. • Cultivate written skills to critically reflect and evaluate outcomes.
Venue	This module will be delivered on Thursdays in Semester 1 from 9.00am until 5.00pm in Hub 2, Level 5, Matthew Building, DJCAD.
Materials/equipment required	Pencils. Pens. Sketchbooks and any other materials necessary to complete the project deliverables. All must be supplied by the student.
Preparation/support – reading lists etc.	Heller A, Vienne V (2003) *Citizen Designer: Perspectives on Design Responsibility*. Allworth Press McDonough W, Braungart M (2002) *Cradle to Cradle: Remaking the way we make things.* North Point Press. Berman D (2009) Do Good Design Chapman J, Gant N, (2007) *Designers, Visionaries and other stories. London*, Earthscan. Benyus J M (1997) *Biomimicry*. Harper Collins Publishers Ltd. Russ T (2010) *Sustainability and Design Ethics.* CRC Press. Fry T (2008) *Design Futuring: Sustainability, Ethics and New Practice*. Berg Publishing.
Deliverables/ Assignments	Coursework (100%) Comprising of: Written Outcome (50%) Practical - project deliverables (50%)
Assessment	Outwith contact time, students are responsible for their own learning and will be expected to engage with other learning facilities (eg library, workshops etc) and peers as required. There are no formal examinations associated with this module. Assessment is conducted through the production of module outcomes, 2 assessable components, 1 written and 1 practical using the criteria set out in the table below.
Student Feedback	**Feedback to Students** After marking at the end of the module, staff will offer written and verbal feedback to students on an individual basis. Feedback will relate directly to the criteria of assessment. **Student feedback to staff** You are encouraged to give feedback on all aspects of the module through an online questionnaire and through your elected representatives who meet regularly with the staff to discuss any issues to do with the course. Difficulties of an academic or personal nature should in the first instance be intimated to your tutor or the module leader.
Absence reporting	You are required to attend for a minimum of 80% of class sessions, which will be monitored through signing in sheets that will be available during each timetabled session. All absences must be reported to Carly Van Wyk, DJCAD Reception (01382 388828 or c.m.vanwyk@dundee.ac.uk) on the first day of absence, and doctor's certificates and/or self-certificate must be handed in to the Undergraduate Office as appropriate.
Curriculum and timetable	Week 1: Introduction to Design Values, Issues & Ethics: Jackie Malcolm. Introduction to Biomimicry: David Sanchez. Introduce Project Brief.

	Week 2: Biomimicry Workshop with David Sanchez. Week 3: Ecological issues with Seaton Baxter. Week 4: Workshop with David Sanchez. Studio session. Week 5: Making Ethical decisions: Jackie Malcolm. Studio session. Week 6: Reading week. Week 7: Workshop with David Sanchez. Studio session. Week 8: Interim presentations Week 9: Workshop with David Sanchez. Studio session. Week 10: Finalise project outcomes. Week 11: Present and submit written and visual outcomes.

DJ31014 Assessment Criteria				
		Criteria (based on Intended Learning Outcomes ILO)		
Grade		**Knowledge of Principles, Methods and Standards.**	**Depth of Concept Development, Exploration and Synthesis.**	**Level of Engagement and Professionalism**
A	**1** / **2** / **3**	An excellent understanding of relevant principles and theories executed to the highest of standards.	An excellent and extremely thorough grounding in researched material. Multiple attempts at divergent and original thinking and exploration of new ideas. An extremely high level of clarity in judgment and decision-making in the development of visual and written material.	An excellent and highly proficient level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
B	**1** / **2** / **3**	A very good understanding of relevant principles and theories executed to a very high standard	A very good and very thorough grounding in researched material. A range of attempts at divergent and original thinking and exploration of new ideas. A very high level of clarity in judgment and decision-making in the development of visual and written material.	A very good and very proficient level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
C	**1** / **2** / **3**	A good understanding of relevant principles and theories executed to a high standard.	A good and thorough grounding in researched material. Several attempts at divergent and original thinking and exploration of new ideas. A high level of clarity in judgment and decision-making in the development of visual & written material.	A good and proficient level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
D	**1** / **2** / **3**	A satisfactory understanding of relevant principles and theories executed to an acceptable standard.	A satisfactory grounding in researched material. Some attempts at divergent and original thinking and exploration of new ideas. Some good judgment and decision-making in the development of visual & written material.	A satisfactory and adequate level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
MF		An unsatisfactory understanding of relevant principles and theories barely hitting acceptable standards.	An unsatisfactory grounding in researched material. Few attempts at divergent and original thinking and exploration of new ideas. Little clarity of judgment and decision-making in the development of visual & written material.	An unsatisfactory and inadequate level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
CF		A poor understanding of relevant principles and theories with no attention to standards.	A poor grounding in researched material. Very few, if any attempts at divergent and original thinking and exploration of new ideas. A real lack of clarity in terms of judgment and decision making in the development of visual & written material.	A poor and low level of level of engagement with staff, clients, external bodies and /or contribution to team-based outcomes.
BF		Non submission	Non submission	Non submission

Appendix A.4. Initial Research Questionnaire and Responses

Design Values, Issues & Ethics

Please can you take time to complete the following survey about the module Design Values, Issues & Ethics. It will only take a few minutes of your time but your feedback will be very valuable to us.

*Required

1. **1. How would you rate your learning experience of the module Design Values, Issues and Ethics? ***

   1 being low and 5 being high.
   Mark only one oval.

	1	2	3	4	5	
Low	⬭	⬭	⬭	⬭	⬭	High

2. **2. How would you rate the knowledge and understanding of the key principles you have learned in relation to your own design practice? ***

   1 being low and 5 being high.
   Mark only one oval.

	1	2	3	4	5	
Low	⬭	⬭	⬭	⬭	⬭	High

3. **3. How valuable did you find the workshop on Biophilia (outdoor/green house exercises)? ***

   1 being not valuable and 5 being very valuable.
   Mark only one oval.

	1	2	3	4	5	
Not valuable	⬭	⬭	⬭	⬭	⬭	Very valuable

4. **4. How valuable did you find the workshop on Biomimicry (learning from nature exercises)? ***

   1 being not valuable and 5 being very valuable
   Mark only one oval.

	1	2	3	4	5	
Not valuable	⬭	⬭	⬭	⬭	⬭	Very valuable

5. **5 How valuable did you find the workshop on Resilience (island community exercise)?** *
1 being not valuable and 5 being very valuable.
Mark only one oval.

	1	2	3	4	5	
Not valuable	○	○	○	○	○	Very valuable

6. **6. How valuable did you find the final reflective workshop on Symbiosis (integration of concepts exercise) ?** *
1 being not valuable and 5 being very valuable.
Mark only one oval.

	1	2	3	4	5	
Not valuable	○	○	○	○	○	Very valuable

7. **7. Has this module made you think differently about your own design practice?** *
Mark only one oval.

- ○ Yes
- ○ No
- ○

8. **8. What other things the workshop exercises awake in you?** *
Tick all that apply.

- ☐ A sense of curiosity and discovery (enchantment with the natural world)
- ☐ A sense of reconciliation between human's and nature's purpose
- ☐ Awareness of what you are going to leave for future generations and our world
- ☐ A new way to see and act in the world I live.
- ☐ Other: ....

9. **9. What are the key themes you feel you will take back to your own design practice?** *
Tick all that apply.

- ☐ Biophilia (related to ecology and personal rediscovery)
- ☐ Biomimicry (related to bio inspired design values)
- ☐ Resilience (related to designing for a living planet)
- ☐ Symbiosis (related to planetary ethics and legacy)
- ☐ Ethics (related to design consciously for others, including non-humans)
- ☐ All of them

10. **10. Can you please provide some comments relating to your learning journey on this module?** *

....
....
....
....
....

11. **11. Do you now feel you have the tools to become the designer of a sustainable and ethical future for human and non-human well-being?** *

Mark only one oval.

- Yes
- No

12. **12. In terms of individual experience, which of the following things did the module cultivate in you?** *

Mark only one oval.

- To rethink my design intentions professionally
- To see the world from different perspectives
- To explore biophilia, biomimicry, resilience and symbiosis through further studies
- Other: ____________________

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7 responses

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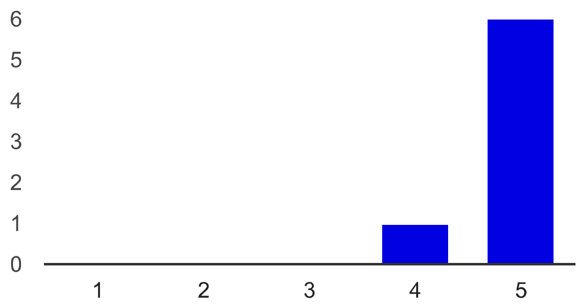
Summary

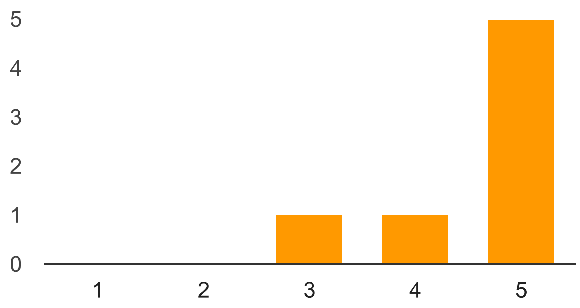
[Image]

1. How would you rate your learning experience of the module Design Values, Issues and Ethics?



Low: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**1**	14.3%
High: 5	**6**	85.7%

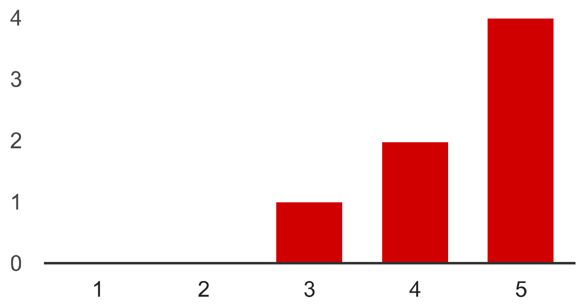
2. How would you rate the knowledge and understanding of the key principles you have learned in relation to your own design practice?



Low: 1	**0**	0%
2	**0**	0%

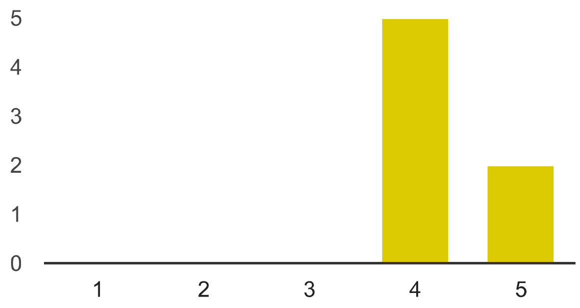
3	**1**	14.3%
4	**1**	14.3%
High: 5	**5**	71.4%

3. How valuable did you find the workshop on Biophilia (outdoor/green house exercises)?



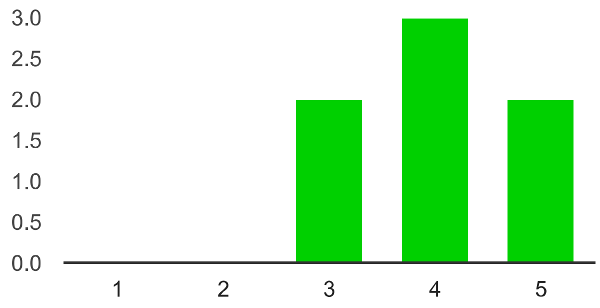
Not valuable: 1	**0**	0%
2	**0**	0%
3	**1**	14.3%
4	**2**	28.6%
Very valuable: 5	**4**	57.1%

4. How valuable did you find the workshop on Biomimicry (learning from nature exercises)?



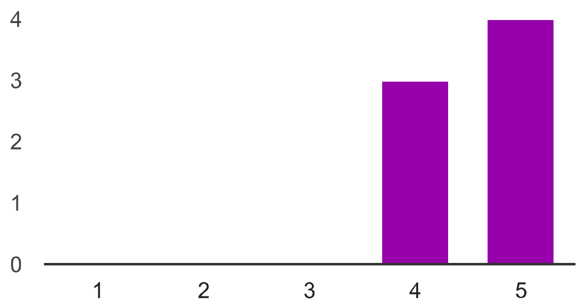
Not valuable: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**5**	71.4%
Very valuable: 5	**2**	28.6%

5 How valuable did you find the workshop on Resilience (island community exercise)?



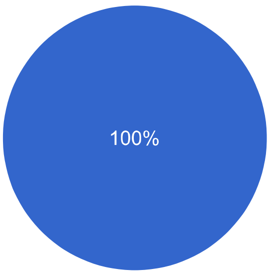
Not valuable: 1	**0**	0%
2	**0**	0%
3	**2**	28.6%
4	**3**	42.9%
Very valuable: 5	**2**	28.6%

6. How valuable did you find the final reflective workshop on Symbiosis (integration of concepts exercise) ?



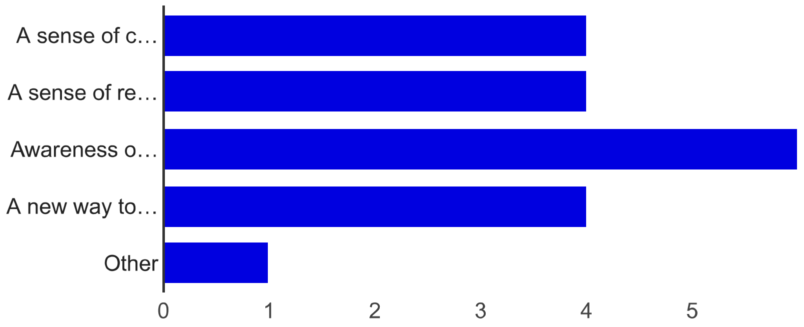
Not valuable: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**3**	42.9%
Very valuable: 5	**4**	57.1%

7. Has this module made you think differently about your own design practice?



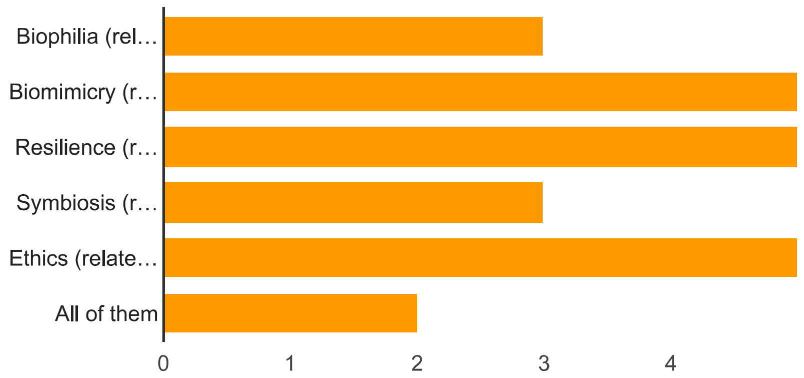
Yes	**7**	100%
No	**0**	0%
	0	0%

8. What other things the workshop exercises awake in you?



A sense of curiosity and discovery (enchantment with the natural world)	**4**	57.1%
A sense of reconciliation between human's and nature's purpose	**4**	57.1%
Awareness of what you are going to leave for future generations and our world	**6**	85.7%
A new way to see and act in the world I live.	**4**	57.1%
Other	**1**	14.3%

9. What are the key themes you feel you will take back to your own design practice?



Biophilia (related to ecology and personal rediscovery)	**3**	42.9%
Biomimicry (related to bio inspired design values)	**5**	71.4%
Resilience (related to designing for a living planet)	**5**	71.4%
Symbiosis (related to planetary ethics and legacy)	**3**	42.9%
Ethics (related to design consciously for others, including non-humans)	**5**	71.4%
All of them	**2**	28.6%

10. Can you please provide some comments relating to your learning journey on this module?

Unfortunately I missed one of the workshops (symbiosis) but the module gave me an insight into what ethical decisions I need to make when designing products. A fantastic module I would say.

At the beginning of the module I was quite unsure what the finished outcome was supposed to be. However I felt this was very valuable as it meant we were able to focus more on the research and development rather than worry about the final solution.

It was so much better than I expected.

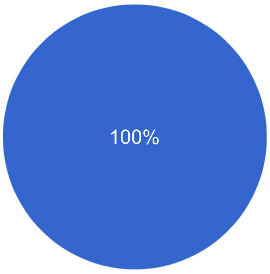
This module was really inspirational and interesting. I felt that my eyes were opened and i began to think wider into my chosen subject. I want to consider ethical branding and advertising in my work and see how I can cimmunicate the importance of learning from nature and experiencing it instead of destroying it.

Gave me an insight about what I want to focus on when I leave uni

I found this module particularly fascinating, I think it benefits is by thinking of nature around us when we come to designing.

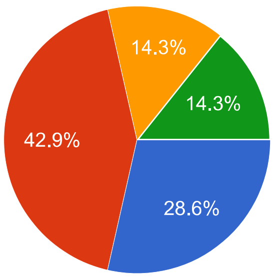
It was great experience and I'm glad that I could be a part of it.

11. Do you now feel you have the tools to become the designer of a sustainable and ethical future for human and non-human well-being?



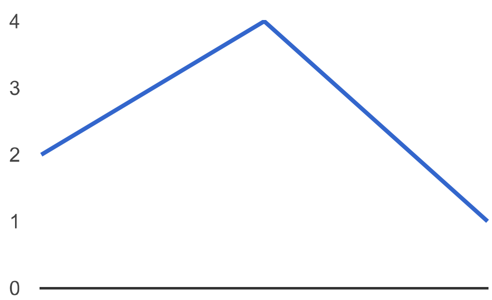
Yes	**7**	100%
No	**0**	0%

12. In terms of individual experience, which of the following things did the module cultivate in you?



To rethink my design intentions professionally	**2**	28.6%
To see the world from different perspectives	**3**	42.9%
To explore biophilia, biomimicry, resilience and symbiosis through further studies	**1**	14.3%
Other	**1**	14.3%

Number of daily responses



A.5 Design Brief

Design Values, Issues & Ethics

Module: DJ31014 Tutors: Jackie Malcolm & David Sanchez

Timetable	Weeks 1-11
Briefing	Thursday 12th September
Presentation / Assessment	Thursday 21st November

Brief: Community

Oxford Dictionary Origin:
late Middle English: from Old French comunete, reinforced by its source, Latin communitas, from communis (see common) noun (plural communities)

1 a group of people living in the same place or having a particular characteristic in common:
Montreal's Italian community
the gay community in London
the scientific community
a group of people living together and practising common ownership:
a community of nuns
a particular area or place considered together with its inhabitants:
a rural community
local communities
a body of nations or states unified by common interests: [in names]:
the European Community
(the community) the people of a district or country considered collectively, especially in the context of social values and responsibilities;
society: preparing prisoners for life back in the community
[as modifier] denoting a worker or resource designed to serve the people of a particular area:
community health services

2 [mass noun] the condition of sharing or having certain attitudes and interests in common:
the sense of community that organized religion can provide
[in singular] a similarity or identity:
the law presupposes a community of interest between an employer and employees
joint ownership or liability:
the community of goods

3 Ecology a group of interdependent plants or animals growing or living together in natural conditions or occupying a specified habitat:
communities of insectivorous birds

Context

'It is … not easy to make quite clear what are the essential characteristics of a desirable local community.' Arne Naess (1989) Ecology, community and lifestyle. Cambridge University Press.

Our sense of community is established because we become familiar to a group of people within a specific location. We achieve a sense of belonging when we become an interactive part of that community. It helps drive our culture, our lifestyle, our health, our values and shapes the way in which we live.

As communities we put systems in place that we believe will make our lives better, helping people in need, and from an early age we learn to become good citizens. As designers we learn to be creative and produce products, media, materials and new technologies that will improve human well-being.

Is our community perfect? Do we ask the right questions? As designers, are we 'good citizens'?

What is a good citizen and how do we define one? How do we measure 'good'?

'Good design is good citizenship.'
Milton Glaser

'Good design is good business.'
Thomas Watson Jr. Chairman IBM

'Good design is … innovative
makes a product useful
is aesthetic
makes a product understandable
unobtrusive
is honest
is long-lasting
is thorough down to the last detail
is environmentally-friendly
is as little design as possible
Dieter Rams 10 principles for good design

What about indigenous peoples? They can show us ethical ways of living and design?

What about non-human communities? Can we learn design values from the bees, plants or sea creatures?

Biological diversity underpins ecosystem functioning and the provision of human wellbeing. It provides human health, food, clean air and water; it contributes to our creativity in creating aesthetic environments, inspiring the development of ornaments, tools or even new technologies. Yet despite its fundamental importance biodiversity continues to be lost.

In the natural world organisms are smart; if human kind starts to understand its strategies and language, together we can be the co-designers of a meaningful way of 'being' with the planet.

Biomimimetic and Biophilic design can help to recognize the ethical intention of design and the creation of communities that encourage the health and well being of its inhabitants and the planet.

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'Life creates conditions conducive to life in everything that it does, besides just meeting its own needs.' Janine Benyus

Design creates conditions conducive to life in everything that it does.

Research

You are asked to research the term 'community' in all its complexities. What is a 'community' and what should it consist of?

Consider this from an ecological perspective. Animals, organisms and plants, in fact pretty much anything that is living, lives in communities, which are intelligent, efficient and enable the species to adapt and survive to changing environments without destroying the planet. The honeybee is a good example of a species that lives in a community where they are nurtured and protected through the systems that exist within their environment.

What would we define as an ethical community with values and beliefs that are conducive to life?

'What might the human-built world look like if a cherry tree had produced it?' McDonough, W. Braungart, M. (2002 p72) Cradle to Cradle.

These are all questions we need to ask as designers. A design can use nature as a model and yet it can still be unethical in its design and realization. What are the ethical dimensions for design?

Consider the values and principles you believe are crucial to achieve an ethical community that can protect and nurture its inhabitants.

'Design is a powerful conduit for change. As the messages, artifacts and experiences we create pass through the hands, minds, and hearts of people, we have an opportunity to weave sustainability into the broader fabric of culture and to shift consumption and lifestyle aspirations to a more sustainable basis for living.' http://www.livingprinciples.org/framework/roadmap/

Brief: Part 1

You will choose an aspect of 'community' from the bag for your team and this will be the subject you will research and design ethically. These are all aspects our human world believe are necessary for a healthy community to protect and nurture its inhabitants.

Looking to nature for your inspiration, you will look at your subject through a new lens of biomimicry. What can nature tell us about our topic? What systems are already in place that we can emulate?

Although this might appear rather radical ways of thinking about design, many examples now exist where nature has informed material, housing, health and systems we come into contact with and use in our everyday lives.

Workshops: David Sanchez
David Sanchez is a PhD student studying at DJCAD in the Centre for the Study of Natural Design. He will deliver 4 workshops that will help you to understand the principles of this brief and what we are asking you to do.

Workshop 1:
Biomimicry: A way of seeing nature.

Workshop 2:
Biophilia: A way of engaging with nature.

Workshop 3:
The Resilient Community: A way to change through nature.

Workshop 4:
Symbiotic Design: A way of participating with nature.

Brief: Part 2

1 There is a written component to this project and you will be given chapters/papers to read for the first 5 weeks. We will discuss these texts in studio the following week and this will help you understand the theory of this project. You will then be asked to produce a Guardian Supplement titled 'How to design a community'. Although there is no word count there is a template for you to use and add your text, illustration and photographs to. You can amend it as you see fit remaining within the grid structure.

2 You are also asked to produce a map of your learning journey. What was your process and how does your journey reflect your experiences? What were the landmarks along the way and what signage would you highlight for anyone trying to understand your project and what it meant for you? Who/what were the inspirations that influenced your work?

It is important you understand the value of your learning experience and that you can reflect critically on the work you have produced, why you have produced it, whether you feel it is successful and what lessons will you take with you to the next project.

Using the REASON design process framework will help you to understand the process of working through this brief and the many complexities it holds.

Aims:
To promote an awareness of the role of design values, issues and ethics within the context of 21st century design.

To introduce the tools and techniques to enable participation in a sustainable and ethical design practice and reflect upon the design process.

To promote the investigation of emerging activity where design thinkers are agents for change, to sustain and maintain human well-being.

To introduce design values and ethical issues through creative practice.

Assessment:

There are 3 parts to this brief:

Part 1 2 A2 boards communicating:
Board 1: research
Board 2: concept development
Board 3: Presentation of prototype
Part 2 Guardian Supplement - individual
Part 3 Visual learning Map of your experience and design process - individual

Teams
You will be working in teams for this project and it is crucial that you all contribute to the dynamics of the team and ensure you give this project your full commitment.

Remember, the more you put in, the more you will get out of it!

Reading List:

McDonough, W. Braungart, M. (2002) Cradle to Cradle: Remaking the way we make things. North Point Press.

Chapman, J. Gant, N. (2007) Designers, Visionaries and other stories. London, Earthscan.

Benyus, J. M. (1997) Biomimicry, Innovation inspired by nature. Harper Collins Publishers Ltd.
Russ, T. (2010) Sustainability and Design Ethics. CRC Press.

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Felton, E. Zelenko, O. Vaughan, S. (2012) Design and Ethics: Reflections on Practice. Routledge, Abingdon, Oxon.

Walker, S. (2006) Sustainable by Design: Explorations in Theory and Practice. Earthscan, UK & USA.

Wilson, E. O. (1984) Biophilia. Harvard University Press

Holling, C S. 1973. Resilience and stability of Ecological Systems. Annual Review of Ecology and Systematics, 4, 1-23.

Blogs and websites:
http://bioinspired.sinet.ca/
http://bioinspiredink.blogspot.co.uk/
http://biomimicry.net/

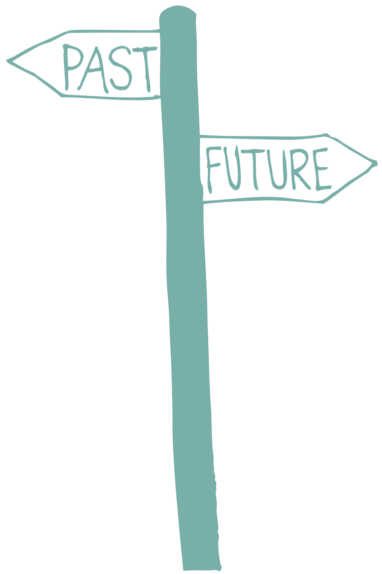
A.6. Reflective Piece Example

How to Design a Community

Mackenzie Palma

Introduction

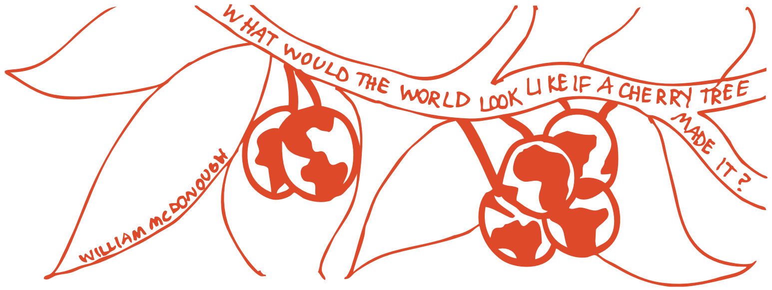
When creating a community, you need to review the past, look critically at the present, and plan for the future. Get inspiration from life's best inventors: plants and animals.



Building a community seems like a very extensive and difficult task. It is a challenge, but there are numerous resources to help spark your creativity. There are people in the world who spend their lives changing people's perspectives about the way we live. They inspire others to think about the Earth when we create and to also think about the consequences of not considering what our designs can cause. Leaders in ecologically aware design include Janine Benyus and William McDonough.

The main issue I discovered throughout the semester is that our world needs to gain a stronger respect for nature. We, as a community, need to re-evaluate our values and ethics and place a larger importance on preserving and caring for the place we live. Plants and animals are a great role model for this type of thinking, and we can learn a lot from the way they interact with the world. We can also learn from other communities around the world, such as the indigenous Kogi people.

I think that it's wise for anyone to reflect on their community and their way of life, and creatively think of ways they can improve them. That's what I feel I have done throughout this process of creating a community.



Analyze Past and Present

In order to create intelligent designs, and therefore create an intelligent community, we have to learn about the world we live in. We can become more knowledgeable in eco-friendly designs from considering the work done by others over many years in this subject.

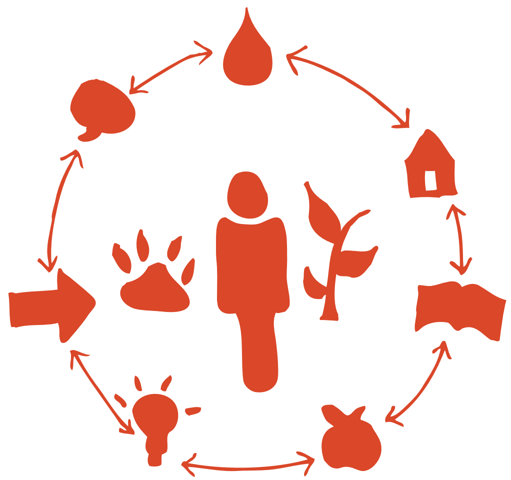
"If nature adhered to the human model of efficiency, there would be fewer cherry blossoms, and fewer nutrients. Fewer trees, less oxygen, and less clean water. Fewer songbirds. Less diversity, less creativity and delight" (McDonough). What a sad and scary world that would be. Its strange that when the perspective is changed, how obvious it is that we don't fully understand how careless we are in our actions towards nature. In the chapter "Eco-Effectiveness" from the book *Cradle to Cradle* by William McDonough,

"What might the human-built world look like if a cherry tree had produced it?"

is a great introduction to thinking like plants and animals do. It asks the question, "what might the human-built world look like if a cherry tree had produced it?" (McDonough). Basically, it would give us all the benefits we need, such as buildings with daylight, fresh air, and a cooling system without harming the environment. This way of thinking is the start to learning from the world around us. As Janine Benyus has said, "What if every inventor, at the moment of creation, could ask: how does nature solve this?" (TEDTalks: Janine, 2009).

A History of Production

Thinking about how our designs will effect our planet seems like an obvious consideration, but our current ways of not thinking about this is deeply rooted into our behaviors and practices. The first chapter of *Cradle to Cradle* looks to our history as designers to figure out where these practices came from. A pivotal moment in history, McDonough explains, is the Industrial Revolution because it changed the way products are made. Things can be made quicker, cheaper, and more efficiently thanks to Henry Ford's assembly line. These things don't come without major consequences, though. In the past, preserving our environment was not a major issue. It seemed as though we had infinite resources, and we were not aware of the limit of the resources we were using. As time progressed, we have learned much more about our environment and how big of an impact are having on it, for example, global warming. As we become more knowledgeable, companie's goals seem to remain the same as they were in the past. These goals most often include creating products as quickly as possible, using the cheapest methods, and the most universal outcomes. One example of this is detergent, which is being mass-produced "for all parts of the United States or Europe, even though water qualities and community needs differ" (McDonough). Even though their intention wasn't to destroy the planet, it is still happening regardless. Harmful chemicals and materials are still being used even though they are not necessary to create certain products. What these chemicals do though, is make it easier and cheaper to produce. As our knowledge grows, our systems remain the same. I learned from this chapter that we need to stop making unintelligent design and start creating informed, conscious design. This is a long-term process and cannot be fixed quickly. If we start at the root of the



problem, routines and systems, we can change the outcome with a strategy of change (TEDTalks: William).

"Having created a technological world, we desperately need to work out how to better understand it."

Strategy of Change

So how do we initiate and expand this strategy of change? Patrick Curry, author of *Ecological Ethics*, calls for a new system of ethics. He says that, generally speaking, the way we are living now with our current priorities "driven by institutionalized ideas and values" needs a serious adjustment. Our priorities are mixed up because of our culture. He explains, "to put it crudely, as did Bertold Brecht, 'Grub first, then ethics'...grub is usually followed by a long list of other concerns which apparently also take precedence over ethics. When these extend to personal security, comfort and glamour, a single person purchasing a four-wheel SUV for use in the city, for example, can seem to make perfect sense" (Curry). I think the world has had major advances in starting to respect our environment, but there is a long way to go. The next step for us is fully integrating this awareness into designs. David W. Orr, author of *The Nature of Design: Ecology, Culture, and Human Intention*, believes that, "what we will need in the decades ahead is to rediscover and synthesize, as well as invent" (Orr). We need to use our skills as designers to create things while also keeping in mind everything our inventions will affect. Braden R. Allenby and Daniel Sarewitz say it best in their article *We've Made a World We Cannot Control*, explaining that, "Having created a technological world, we desperately need to work out how to better understand it, and how to live in it rationally, responsibly, and ethically" (Allenby).

What is a Community?

A community can have so many different meanings depending on the context. Within the context of our world, I think that a community encompasses more than just a group of humans. The natural world is the entire reason that we are able to exist on this planet. It provides us with all the materials humans require for survival. For me, a community is:

A system made up of humans, animals, and plants on Earth who work together to protect each other as well as the air, water, and other elements that create our environment.

Members of the community should give and take to benefit each other in respectful and innovative ways. We can all strengthen our community by remembering nature when considering our personal values.

Learn From Experience

One of the most critical parts of learning is to gain information about someone or something from hands-on activities. In four workshops created by David Sanchez and one by Seaton Baxter, we gained insight into the many different ways of looking at the world. Located at the University of Dundee's Botanical Gardens, we were able to step outside and learn in the context of a natural environment to begin to build our communities.

Use the Blueprints

One of the first steps in learning how to build a community is to observe and understand the natural world. The natural world can teach us a great deal about how to work with and for one another; leaving the organism, the species, and the Earth with some sort of benefit. Plants and animals in the natural world have perfected their way of life over billions of years, which makes them an obvious resource to look to for solutions. Janine Benyus, the so-called leader of biomimicry, makes the important distinction that "Learning about the natural world is one thing, learning from the natural world...that's the profound switch" (TEDTalks: Janine, 2007). Nature has had billions of years to perfect its systems, and has already found solutions to the problems that we face today. Not only do plants and animals have these solutions, but they have also done it in a way in which they are protecting our home, not destroying it. Although what they consider their home we also consider to be own home, we treat it very differently. This theory can be described as biomimicry, one of four main categories that can be studied to assist the process of creating ecologically-aware designs. The other three categories are biophilia, resilience, and symbiosis. These were taught to me through different workshops created by David Sanchez.

Build a Relationship

Biophilia is a way of engaging with nature, to connect and consciously sense the natural world on a deeper level. In this workshop we completed different activities to help achieve this sense of nature. We took a few moments to focus on nothing other than nature by carefully listening to the sounds, and smelling our surroundings within the gardens. We also did a "mindful movement" exercise, in which we placed ourselves among nature and mimicked its natural forms. This exercise made us focus on the fact that nature lives with us, not for us. Many people seem to forget this. The world was here billions of years before us and has crafted an Earth that is so precise and pure in its ways, and we must respect this. This workshop made me mindful of the world on a spiritual level and created a deeper connection with me and my everyday surroundings.

> "Learning about the natural world is one thing, learning from the natural world...that's the profound switch."

Learn to Adapt

One of the most amazing things about our world is that if something is destroyed, life finds a way to recreate and adapt to its ever-changing surroundings. This ability to continue and rebuild after a huge transformation is called resilience. We explored this idea by creating our own island, experiencing complete destruction of it, and rebuilding it up again. We created the island from various soil, plants, rocks that we found throughout the gardens that would be the foundation of our island. All of us who created the island had to work together to make the basic shape and geography while we assumed the role of one aspect, such as river or mountain. This part of the exercise showed us that natural occurring systems work together as necessity to create a landform. Then we each had a role in the island such as farmer, doctor, or hunter, and placed ourselves in the best location we thought we belonged within the small community. This further showed how aspects of communities must work together to inform their own decisions. When the destruction of our island happened, we needed to rebuild. We built our community back up with our locations changing depending on how "nature" moved us. I learned from this workshop that even though natural disasters occur, reconstruction is necessary and intuitive. It proved that communities can and must change with the environment.

Connect the Dots

The last workshop was about joining all three of these ideas together and allowing them to work together simultaneously, defined as symbiosis. We evaluated our primeval bio-culture and compared this to our present bio-culture. By analyzing the two, I discovered that we can create our future symbiotic bio-culture by noticing the differences between the two. I came to the conclusion that humans and nature can work together to mend our planet using our creativity and technological skills. We need to further consider how we can appreciate, learn from, and work with nature all at the same time. The world can work as a system by not just taking from one another but also giving. We need to re-evaluate our values and ethics, keeping in mind our world and everything in it.

Learn From Others

A three part conversational workshop led by Seaton Baxter entitled "Design and the End of the Beginning". The three parts included: Man and Nature- The Kogis, The Community of the Dead, and Beginning Again.

In the workshop given by Seaton Baxter, we explored the life of the Kogis. The Kogis are indigenous people living in Columbia, and a group of people we have much to learn from. When thinking about food in relation to the Kogis, it is obvious that they have a very deeply rooted respect for the food that they grow and eat. In their culture, they are able to go much longer than us without eating food and they are always chewing on coca leaves. They hold the belief that all plants have guardians and they must be blessed. They ask these guardians permission for their crops to grow, and if they do not ask permission, then they will not grow properly. While most of their actions may not be suitable in such a large society, their philosophies behind their actions can be incorporated into our daily lives.

Consider All Options

There are many different parts that make up a community such as transportation, communication, water, tools, education, and housing. My group focused on the role of food within a community and how to create a new environmentally aware system.

What Does Food Mean to Us?

My group started with a brainstorming session thinking of every possible association of food we could think of. We quickly realized that there are so many different directions we could take when beginning to plan our new community. We began to think about what food means to us and its role in our community and other communities around the world. In order to start from the very basics of food, we thought it would be best to look at what role food played in the lives of cavemen. We noted how cavemen interacted and gathered their food. One example of this is that when they killed an animal, they used every single part of that animal for either food, tools, or warmth (fur). Then we compared this caveman food culture to the relationship we have with food today. We decided that there are things we could learn from both cultures and took the best from both to create the foundation of our new community.

A Working System

Then we started to think about the details of our new food community. We created three separate circles that would connect our ideal community. At the core is education, because we felt that it is important that from an early age that children begin to form a relationship with food. The main focus would be on what one is eating, where the food comes from, and how it grows. Education then expanded into a food culture in which the society as a whole interacts and respects the process of food production. This led us to the third and final circle: food industry. We began to think about how we could fix the problems in our food industry today, such as waste, harsh chemicals, and over-processed food.

> "We began to think about what food means to us and its role in our community."

A Clear Direction

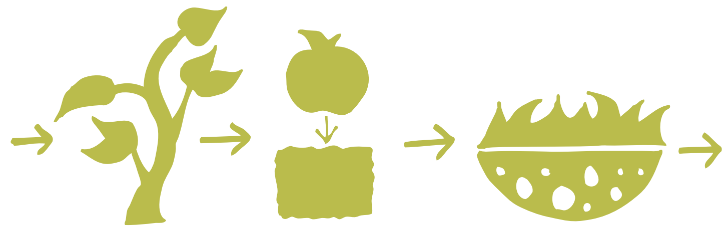
As this is an extremely big area to explore, we narrowed our focus to just the industry. We felt that biggest problems with our current food industry are chemicals in the soil and waste from excessive packaging. These two issues became the main problems that we needed to create a different system for than the current one we have now.

Inspired by Nature

Ants and Termites
Both ants and termites have a very complex system. Both species work together to gather food and create their intricate tunnel systems underground. These insects are valuable to learn from because of their ability to share and distribute food throughout their entire community.

Marsh Snail
We studied the marsh snail because of its ability to recycle nutrients in the soil. Their system also ensures their survival, so in doing so they are creating a benefit for themselves as well as the soil. We considered their way of recycling nutrients when creating a new system for fertilizer.

Worms
Another organism that tends to the soil are worms. They aerate the soil as the travel through it, creating a better area to grow. We also considered their system when creating a new system for fertilizer.



Our Solutions

We created a packaging and fertilizing system and a farm design which work together to create our ideal food community.

The Paper Wasp

For the packaging and fertilizing system, we were inspired by the paper wasp. The paper wasp gathers fibers from dead wood and plant stems and mixes them with their saliva to create a waterproof, paper-like structure. The naturally occurring chemicals in the wasp's saliva is an insect repellent, which protects their food and offspring. When the nest is no longer occupied, it will fall to the ground and decompose back into the soil. To solve what we believed were the biggest problems in today's food industry, excessive waste and dangerous chemicals in fertilizer, we found a solution to both of these issues in the paper wasp's behavior.

Applying the "Genius"

We came up with the idea to mimic the paper wasp's nest for a new material for packaging. This package would be made entirely out of substances from the earth, so it would be completely natural. These substances would be taken from plants that are leftover after harvest and would otherwise have been left to decay. This would also solve the issue of wasted plant materials, one aspect of "post-harvest losses". Unwanted weeds and shrubs can also be used in the mixture, not disturbing any living plants that could be used for something else. This packaging would also be ideal because it would contain the natural chemicals similar to the paper wasp's saliva that would naturally repel insects away from the food inside. After the product was used, the package would then be able to decompose back into the soil, just like the paper wasp nest. It would then be recycled and used as a fertilizer and natural pesticide.

> "The cycle starts with plants then transforms into packaging, which transforms into soil, which then recycles back into plants."

The Location

When creating this new system, we imagined it happening on an island in a climate like Scotland's. On this island, there would be no waste products, like plastic, because everything would use our natural packaging. There will also be no use of pesticides in the soil or any other harsh chemicals that are not necessary to the crop's growth.

The Endless Cycle

We also created a layout plan of one of the numerous farms located on our island. These farms will have a rotating plan, so that each field around the farm does not grow the same crop every single year. Instead, the crops are rotated around to help recycle and preserve the nutrients in the soil. Each farm would also have its own packaging creation unit. In this unit, they will use the resources from their farm, such as dead fallen plants that can no longer be used, and create the packaging right there. Each farm has it's own unique mold or symbol on the packaging so that they will receive the same amount of packaging back as they send out. This packaging keeps the farm alive and replenishes the soil. This cycle of the farm mimics the theme of cycles in our whole design. The cycle starts with plants then transforms into packaging, which transforms into soil, which then recycles back into plants. With this infinite recycling system, we will never create excessive waste or run out of resources.

Reflection

Reflecting on what I have learned has allowed me to really appreciate this entire process and I can now envision myself using these ideas in the future.

How Can We Help Nature?

If I could sum up everything I've learned into one example from nature, it would be the way the Brazil nut depends on the orchid for survival. In the rainforest, the Brazil nut tree drops its seeds to the ground. Once on the ground, the agouti discovers it and collects these nuts. It may eat one, and then it scatters the rest throughout the rainforest for later. The Brazil nut needs the agouti to spread its seeds around so that the species can continue to grow, and the agouti needs the Brazil nut for a food source. To create the actual seed on the tree, the Brazil nut needs a female orchid bee to pollinate it, because they are the only ones strong enough to get to the nectar inside the flower on the tree. The female bees need the male bees, which need the orchid flower to pollinate and get perfume to attract the female bees. In this system, all of the organisms depend on each other for survival. Their actions results in a benefit for themselves, such as the agouti gaining nutrition from the Brazil nut, and a benefit for another organism, such as the agouti spreading the seeds. All of their systems are designed this way: to work together, however indirect, and keep each other alive. To me, this is a very beautiful and developed interaction between these species, and I think that we humans need to do more to benefit other species as well as the world. We need to not only think about what nature can do for us, but what we can do to benefit nature as well.

> "We need to not only think about what nature can do for us, but what we can do to benefit nature as well."

Looking to the Future

Throughout the semester, I've experienced a lot of engaging, challenging, and thought-provoking subjects forcing me to think about things in a new way. Collaborating as a team allowed us to react to each other's ideas and create something better than we could have alone. The lessons and ideas we developed together will influence my future career and life, and will guide my thinking in my projects from now on. When I create a new design, I will consider where it will end up and how it will interact with the world. It's important to think about our human impact on such a large scale, and what we have caused to such a beautiful and perfectly assembled world. If everyone recognized the value of our world and how much we are actually destroying it, things would be very different. Not only should people realize this though, we must also be aware that there is a solution. I am reassured knowing that there are people in the world who have recognized these problems and know that the best way to solve them is to look to those who have already solved all of these problems: animals and plants within nature. Asking ourselves the question "how would nature solve this?" should be in the minds of every designer out there.

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TEDTalks: William McDonough, The Wisdom of Designing Cradle to Cradle. Perf. William McDonough. TED, 2007.

Source Information

These sources were obtained from readings given out throughout the semester and from materials and videos shown in class. They were provided by Jackie Malcolm and David Sanchez for further research into our topics.

Author Biographies

Janine Benyus

"Janine Benyus is a biologist, innovation consultant, and author of six books, including Biomimicry: Innovation Inspired by Nature. In Biomimicry, she names an emerging discipline that seeks sustainable solutions by emulating nature's designs and processes (for instance, solar cells that mimic leaves).

Since the book's 1997 release, Janine has evolved the practice of biomimicry, consulting with sustainable businesses and conducting seminars about what we can learn from the genius that surrounds us. Her favorite role is biologist-at-the-design-table, introducing innovators to organisms whose well-adapted designs have been tested over 3.8 billion years.

An educator at heart, Janine believes that the more people learn from nature's mentors, the more they'll want to protect them. This is why she writes, speaks, and revels in describing the wild teachers in our midst."

SOURCE: BIOMIMICRY.NET

William McDonough

"William McDonough is a globally recognized leader in sustainable development. Trained as an architect, Mr. McDonough's interests and influence range widely, and he works at scales from the global to the molecular. Time magazine recognized him as a 'Hero for the Planet,' noting: 'His utopianism is grounded in a unified philosophy that—in demonstrable and practical ways—is changing the design of the world.'

Mr. McDonough is the architect of many of the recognized flagships of sustainable design, including the Ford Rouge truck plant in Dearborn, Michigan; the Adam Joseph Lewis Center for Environmental Studies at Oberlin College; and NASA's "space station on Earth," Sustainability Base, one of the most innovative facilities in the federal portfolio."

SOURCE: MCDONOUGH.COM

Appendix B.1. Audio-Visual Biophilia examples

TV programmes

Super Smart Animals (BBC, 2012). Synopsis: Two episodes that shows how the latest science reveals that animals are a lot smarter than we thought. [1]

YouTube videos/clips

Our living planet. Synopsis: A clip made of footage from several factual series of programs from the BBC, Secrets of Our Living Planet(2012) -a ground-breaking, global nature series with Chris Packham, showcases the incredible ecosystems that make life on Earth possible[2] - and Nature's MicroWorlds(2012) -Series in which Steve Backshall looks at some of the world's most iconic ecosystems.[3]
Link:https://www.youtube.com/watch?v=3nmnMtbzzjE&list=PLS4YXOpOsE_L54JKcXJToWKTj9VGixxSm&index=1 (Last seen 1/09/2015)

UN Decade of Biodiversity (2011). Synopsis: Video produced by the United Nations on his strategy to support the implementation of the Strategic Plan for Biodiversity 2011-2020 adopted by the Conference of the Parties at its tenth meeting held in Nagoya, Japan. The video displays current problems of human behaviour and how animals are the key to generate wellbeing.[4]
Link: https://www.youtube.com/watch?v=zpM-nkhZCgk (Last seen 1/09/2015)

Documentaries

Home (2009). Synopsis: Documentary directed by Yann Arthus-Bertrand. The film is almost entirely composed of aerial shots of various places on Earth. It shows the diversity of life on Earth and how humanity is threatening the ecological balance of the planet. It was released simultaneously on 5 June 2009, in cinemas across the globe, on DVD, Blu-ray, television, and on YouTube, opening in 181 countries. The film was financed by Kering, a French multinational holding company specializing in retail shops and luxury brands, as part of their public relation strategy. [5]

Earthlings (2005). Synopsis: American documentary film directed by Shaun Monson. The film is about humanity's use of other animals as pets, food, clothing, entertainment, and for scientific research. [6]

[1] BBC1, "Super Smart Animals" (UK, 2012), http://www.bbc.co.uk/programmes/b01by613.
[2] "Secrets of Our Living Planet - BBC Two," *BBC*, accessed October 1, 2015, http://www.bbc.co.uk/programmes/b01k73zy.
[3] "Nature's Microworlds - BBC Four," *BBC*, accessed October 1, 2015, http://www.bbc.co.uk/programmes/b01l2swt.
[4] UNBiodiversity CBD, *United Nations Decade on Biodiversity - Official Video*, 2011, http://www.youtube.com/watch?v=zpM-nkhZCgk&feature=youtube_gdata_player.
[5] "*Home* (2009 Film)," *Wikipedia, the Free Encyclopedia*, September 12, 2015, https://en.wikipedia.org/w/index.php?title=Home_(2009_film)&oldid=680691707.
[6] "*Earthlings* (film)," *Wikipedia, the Free Encyclopedia*, September 9, 2015, https://en.wikipedia.org/w/index.php?title=Earthlings_(film)&oldid=680167509.

Appendix B.2 Dundee Botanic Garden Educational Facilities Description

As centres for the study and conservation of plan diversity, botanic gardens have an acute understanding of the impact of climate change on plan life. Botanic gardens have a wide and deep knowledge of plant cultivation, plant distributions, plan survival strategies and plant habitats and an understanding of the complete dependence of humanity on plants. With knowledge comes responsibility. Botanic gardens are obliged to evaluate the evidence and to explain to the public the likely effects of mankind's activity, including climate change, on plant diversity and therefore on human life.

The main layout of the *Dundee Botanic Garden* is geographical and you can walk through the world's temperate regions from the Mediterranean to East Asia. A commitment to plant ecology resulted in the central British Native Plants area where you can experience the changes in plant adaptations and plant communities from high in the Angus glens down to the sea, via a variety of woodland types. The Glasshouse sous the contrasting rainforest and desert habitats, so much of the world's plant lifestyles can be enjoyed and studied here. Finally the central philosophical theme of plant adaptations and there evolution is celebrated in the Evolution Garden.

Garden of Evolution
This Garden of Evolution show plan evolution from the green algae to the flowering plants. It is a demonstration of the least 1200 million years of plant evolution and nearly all the major groups of land plants are represented. As you walk through this garden, you will experience the great sweep of earth's history and see how each new group of plants has evolved new adaptations to ensure survival on the land. The garden is set in a maze of dry-stone dykes which in themselves display many interesting details. Look out for plant shapes, a pyramid and a monster.

Glasshouse
The glasshouses demonstrates plant life in the tropical rainforest, where citrus fruit can be frequently found, coffee beans grow and the pond contains giant water lilies. The other glasshouse takes you on a journey through a temperate region with bananas and insectivorous plants, to an arid zone with cacti and other succulents. There is also many plants used by people for medicine, fuel and clothing. The major areas of teaching and research are concentrated on the physiological function of plants, their survival strategies, ecology, symbiotic and family relationships. The Garden, therefore, has no brief to make large collections of plants based on purely aesthetic considerations or even on grounds of botanical curiosity.

Native Plant Communities
One of the most important features of the Garden is the Native Plant Communities Unit. Here, a series of plant associations has been established to represent types of vegetation that can be found in Britain. Sited in a layout running north to south are representatives of the mountain and uplands areas, dwarf scrub, pine and birch forest, ash wood, oak and beech forest and, at the lowest point, a nutrient-rich pool. These are linked by a burn, which is fed from a spring in the North West corner of the Garden. The woody plant elements are now sufficiently mature to allow the introduction beneath the trees of the associated field layers and the woodlands are already proving a useful teaching resource for students, school pupils and the general public.

Unlike a taxonomic layout, where plants are assembled in un-natural groupings that show supposed evolutionary relationships, the layout of the Botanic Garden respects the real nature of vegetation, thereby promoting familiarity with native plants from all over the British Isles, as well as providing a useful guide to their ecology. Although not a substitute for field study, this is vital where the curriculum is already crowded.

Exotics
The remainder of the Garden is given over to layouts of exotic plants with a similar ecological and geographical basis. Already there are noteworthy collections of conifers, Australasian, Asian, North American and Mediterranean plants, primitive flowering plants, and aquatics. The garden's favourable climate can be judged by the successful cultivation of plants which would normally be considered too tender to survive in the east of Scotland. Regnellidium diphyllum, a floating aquatic fern from Rio del Sul in Brazil, is an example of an unusual plant which thrives in the Garden. Normally very difficult to grow, it seems to luxuriate not only in the temperate and tropical glasshouses but also in one of the necklace ponds which feed Loch Machar - the exotic plant pool near the Visitors' Centre, built with funds provided by Alex Machar, a former Curator of Grounds in the University, who was the first to realise the potential of the site. Other collections include examples of physiological adaptations to wet, dry, tropical and temperate zones, and of the strategies that plants have evolved to overcome hostile conditions.

For more information please consult http://www.dundee.ac.uk/botanic/

Appendix B.3 Sample of a research questionnaire on biophilia

Workshop 1: Biophilia (Research evaluation)

Note: Take one minute of silence to remember last session activities and concepts learned.

1. Which of the following activities did you enjoy the most? Remember that all of them were created to ignite biophilia in you as an individual in order to reconnect your mind and body with the Earth and all the living.

( ) Presentation and videos
( ) Sense of place/Meditation (senses/blindfold)
( ) Mindful Movement (body movement)
( ) Improvisation game (animal feelings)
( ) Goethean drawing (plant observation)
( ) All

2. What do you think biophilic practices are good for:

( ) Develop my sense of curiosity
( ) Increase my sense of creativity
( ) Enrich my ethical decisions
( ) Other_____________

3. What do you consider can be improved in Workshop 1: Biophilia?

( )outdoor activities ( )videos ( )presentations ( )teaching space ( )All OK

4. What means **Biophilia** for you?

____

5. Do you think designers need to know more about biophilia during university?

( )Yes ( )No

Why?

____

6. If you have any question in relation to the workshop please write it down here:

____

7. Finally, what was your average experience in Workshop 1: Biophilia?
(1= bad experience to 5 = great experience)

1 2 3 4 5

Appendix B.4 Table of Typology of Biophilic Values (by Kellert)

Value	Definition	Function
Aesthetic	Physical attraction and appeal of nature	Harmony, security, creativity
Dominionistic	Mastery and control over nature	Physical prowess, self- confidence, mastery skills
Humanistic	Emotional bonding with nature	Bonding, cooperation, companionship
Naturalistic	Exploration and discovery of nature	Curiosity, exploration, discovery
Moralistic	Moral and spiritual relation to nature	Order, meaning, connection
Negativistic	Fear and aversion of nature	Safety, protection, awe
Scientific	Systematic and empirical study of nature	Knowledge, understanding, critical thinking skills
Symbolic	Nature in language and expressive thought	Communication, mental development, analytical skills
Utilitarian	Material and physical exploration of nature	Physical sustenance, material productivity, survival skills

Appendix B.5 Schedule of a day session on Biophilia

Workshop 1

Biophilia: A way of engaging with Nature.

Description

Biophilia, the innate inclination to affiliate with the natural world (Wilson&Kellert, 1993), is linked not just to the material exploitation of the environment but also to the influence of the natural world on our emotional, cognitive, aesthetic, an even spiritual development. The activities we going to experience will set the first steps towards an ethical way of *co-design with nature*.

Aims

- Recognize biophilia tendency as the first step in the pursuit of design ethics.
- Identify the biophilic values as indicators of the human dependence on nature
- Acquire a mindful way of engaging with the natural world through our human senses.
- Acknowledge the fundamental smartness of biodiversity in creating conditions conducive to life.
- Distinguish Biophilia as an ecological technic for the development of meaningful designs.

Agenda

9:30- 9:50 Book chapter review: Cradle to Cradle

9:50-10:20 Presentation Workshops | What is biophilia?

10:20-10:30 Video: Our living planet

10:30-12:30 Outdoor Activities: Sense of Place | Mindful Movement

12:30-1:30 Quiet Lunch

1:30-2:30 Re-connecting with nature: Goethean method (Hothouse)

3:30-4:00 Game: Bio-translate | Video: Smart Animals | Video: Community of Life.

4:00-4:30 Defining the "Community" context (group mapping)

Dundee Botanic Garden, 2014-09-25

Appendix B.6 Mindful Movements Illustrated

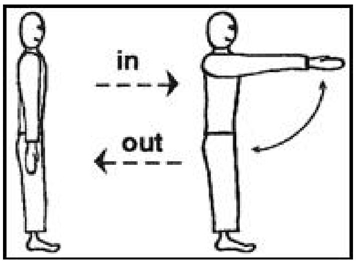
Mindful Movements are a series of ten physical exercises introduced into the practice by Thich Nhat Hanh several years ago. They are often conducted by the community as a group but can be practised on one's own. Typically, the mindful movements will take place outside in a circle after a walking meditation or sometimes indoors during a dharma talk in order to stretch the body.

Each movement should be carried out three times before proceeding to the next. Body movements should be flowing and graceful and not too rapid. Each movement is coordinated to be in harmony with our breathing. The mindful movements give us a chance to exercise. They allow us to practise sensitivity and awareness to our body, our breathing, and the interconnectedness between our body, our breathing and our mind.

The diagrams and text below give a brief description of each movement:

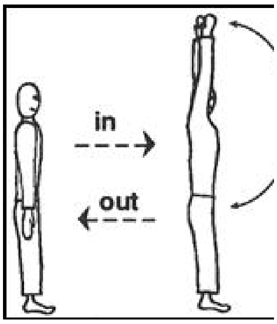
Mindful Movement 1

Stand upright with feet slightly apart facing forward. On the in breath raise both arms so that they are horizontal, hands loose and palms facing downward. On the out-breath lower both arms to your side.



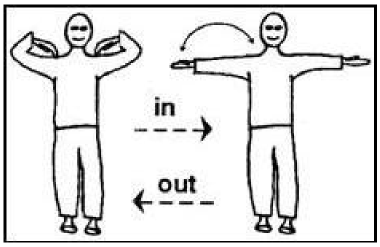
Mindful Movement 2

Start as in Movement 1 with palms facing inwards. On the in-breath raise hands above the head keeping the arms straight to make a semicircle in front of the body. Stretch the body without the feet leaving the ground. On the out-breath reverse the movement, lowering the arms and returning the hands to rest on each side.



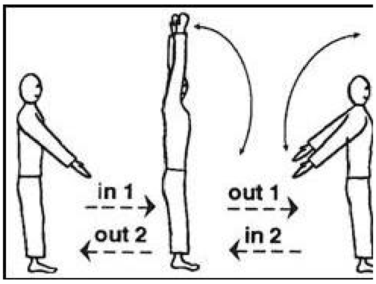
Mindful Movement 3

Start with feet slightly apart and arms bent at the elbow and fingertips touching the top of each shoulder. The arms are in the same plane as the body. On the in-breath stretch both arms so that the arms are fully out-stretched, palms upward. On the out-breath return the arms again to the start position.



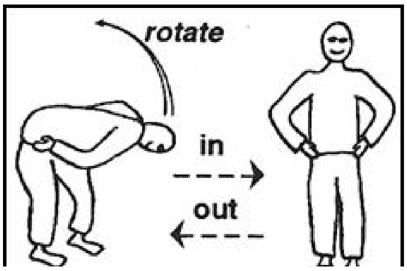
Mindful Movement 4

Start with arms and eyes facing forward. Palms should be together at waist level in front of the body. On the first in-breath lift the arms (keeping them straight). The hands stay together at eye level. Keeping the movement continuous, take the arms up and out over the shoulders (hands are now separated) and on the first out-breath bring them down behind the body (thus making a big circle with each hand). With the second in-breath reverse the movement bringing the hands above the head and then on the second out-breath bring hands down to the start position.



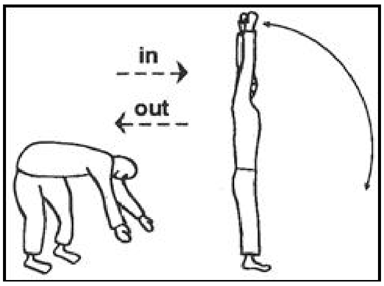
Mindful Movement 5

Stand with feet slightly apart and hands resting on the hips. Start by leaning forward with head at waist level, legs straight. With the first in-breath rotate the body clockwise pivoting around the waist. The head should describe a wide circle and after the in-breath the body is leaning backwards and upright. On the out-breath reverse the movement taking the head back to its starting position in front of the body. After repeating this cycle three times repeat the movement but rotating the body anti-clockwise.



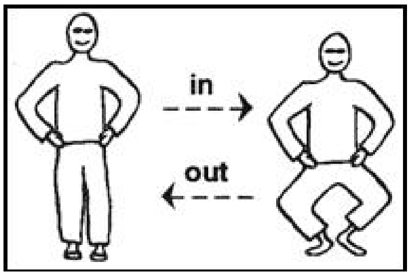
Mindful Movement 6

Start by leaning forward allowing the arms to hang downwards. With the first in-breath lift up the body from the waist, taking the hands in a wide semi-circle so that the arms stretch upwards. Stretch the whole body. On the outbreath reverse the movement returning the body to its starting position, leaning forward arms loosely downwards.



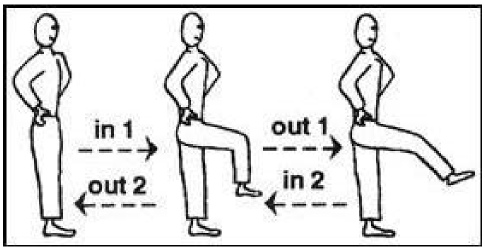
Mindful Movement 7

Stand with hands resting on hips and feet together at the ankles, slightly apart at the toes. On the in-breath stand on tiptoe and then, with back kept straight and hands on hips, bend at the knees taking the torso down towards the ground. Ankles should stay together. With the out-breath straighten the legs and return to the original position.



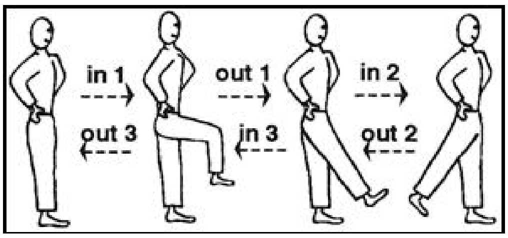
Mindful Movement 8

Stand upright with hands on hips, feet together on the ground. With the first in-breath raise the right leg so the knee is just below the level of your waist, the lower leg hanging downwards. With the first outbreath extend the lower half of the leg so the leg is almost straight. With the second in-breath describe a semi-circle with the right foot pivoting around the ankle and bring the lower leg down to its position after the first in-breath. With the second out-breath return the leg to its start position beside the body. After completing this cycle three times with the right leg, repeat three times with the left leg.



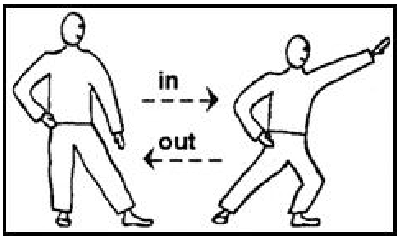
Mindful Movement 9

Stand upright with hands on hips, feet together on the ground. With the first in-breath bend the right leg and then with the out-breath straighten and extend the leg out in front of the body with the foot just above the ground. With the second inbreath swing the foot around the body to the side, keeping the leg straight and describing as wide a circle as possible so that the foot ends up behind the body with the toe touching the ground. With the second out-breath reverse this movement so the foot returns to its position extended in front of the body. With the third in-breath bend the leg so the foot is below the knee and with the third out-breath return the foot to its start position. After repeating this cycle three times repeat the movement with the left leg.



Mindful Movement 10

Stand upright with your feet a good step away from each other. The left foot should point forward and the right foot point at right angles to this, pointing outwards to the side. The left hand should be on the left hip and right arm should be pointed down the right leg with fingers extended. Your face should be looking sideways in the same direction as the right foot. With the in-breath bend the right leg and raise the right arm, stretching and extending it to just above shoulder level. This should produce a stretch along the left side of the body. With the out-breath reverse the movement returning to the start position. After repeating this cycle three times repeat the movement on the other side of the body (i.e. bending the left leg).

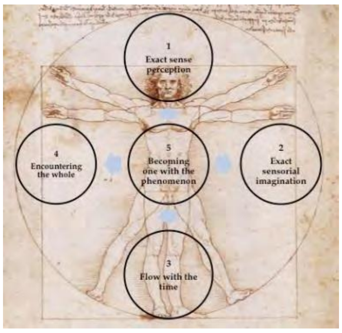


After completing the Mindful Movements, we stand with palms together in the shape of a lotus, and bow to the rest of the community.

For more visual guidance follow this video link: https://www.youtube.com/watch?v=FCUyf-IPPoQ

Appendix B.7 Goethean Method Instructions template (foldable)

Goethean method of observation



****Unfold 1 step at a time**

Step 1. Active perception

Description: A detailed sensory-based observation of the phenomenon is undertaken. The organism is seen as if for the first time.

Instructions: You will select a plant of your preference and find a relaxing posture to observe it. This plant is a unique. Ask yourself: What is this? Observe it quietly for 2 or 3 minutes.

Step 2: Exact imagination

Description: In this phase the imagination is engaged as a legitimate tool for scientific or artistic observation. We are able to focus our awareness by imagining the impossible.

Instructions: Stop looking at the organism by turning back or moving away from it and then start drawing the organism as you remember it: Branches, shape of leaves, colours.

Unfold

Fold the line

Step 3: Encountering

Description: On this stage the aim is to suspend active perception and, as much as possible only receive. We allow the organism to express itself.

Instructions: Now get back to observe the organism and be ready to encounter it. See who really is. It is no longer a thing but a living individual organism. Let it to express her/himself. Revisit your drawings and continue adding more details: hidden leafs, colours, dry branches, roots, textures, etc. After you finish call her/him with a name. (You can introduce yourself if you like)

Step 4: Flowing imagination

Description: What was observed as static, disconnected parts are now brought together and made fluid in the imagination as dynamic process in time.

Instructions: The dynamic transformation envisioned in the previous stage now is deepened to reveal the formative gesture of the organism. Using again your imagination, and observing your drawing you will imagine how its roots are growing underneath, and try to think in the relationships with other beings (bees, fungi, moss, other plants, etc.) adding some to your drawing in a subtle way. In one of the corners or another sheet draw its life-cycle (from seed to decay).

Unfold to the last step

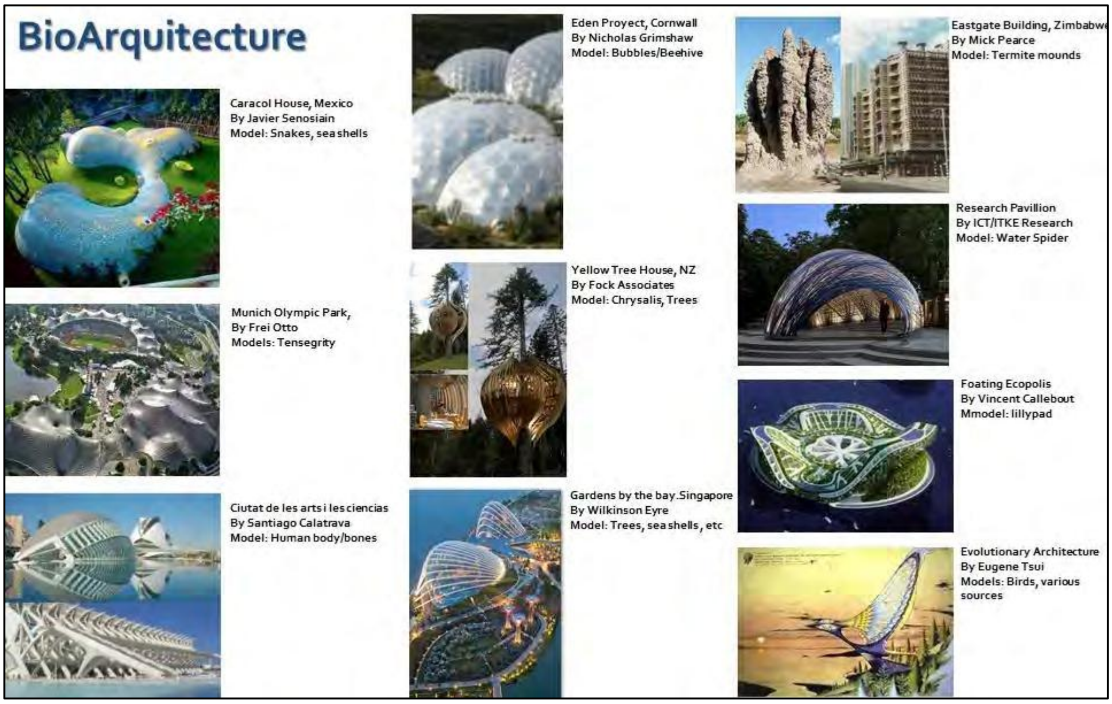
↓

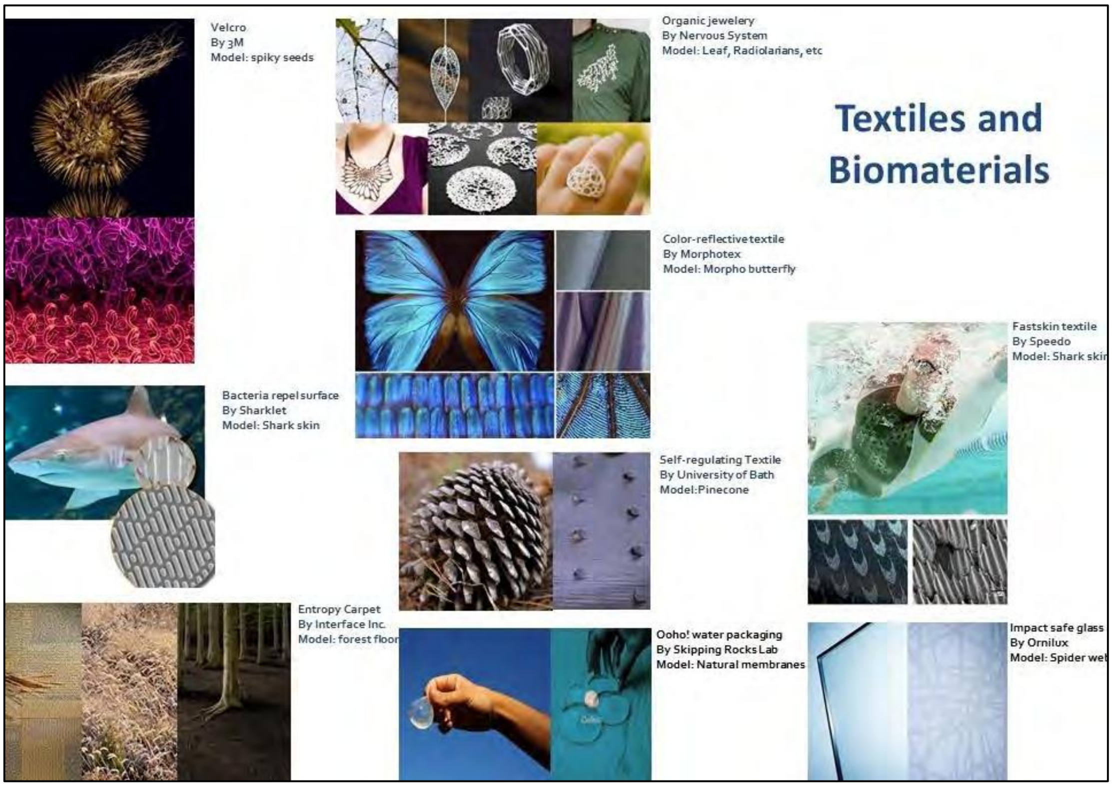
Step 5. Becoming one (Intuition)

Description: Through intuitive perception we merge with the organism' form to grasp its inherent meaning or creative potency. As we become one with the organism, we conceptualize to serve the organism: we lend it this human capacity.

Instructions: Now observe your work and ask what is the intention of the organism to the world? Observe around to find some clues and see how nature relates to us. As we rediscover nature, we become conscious and responsible participants in, and integral parts of, Nature. The emotion that you experienced by seeing yourself as part of nature must be expressed in a short poem/story tale, or an ornament.

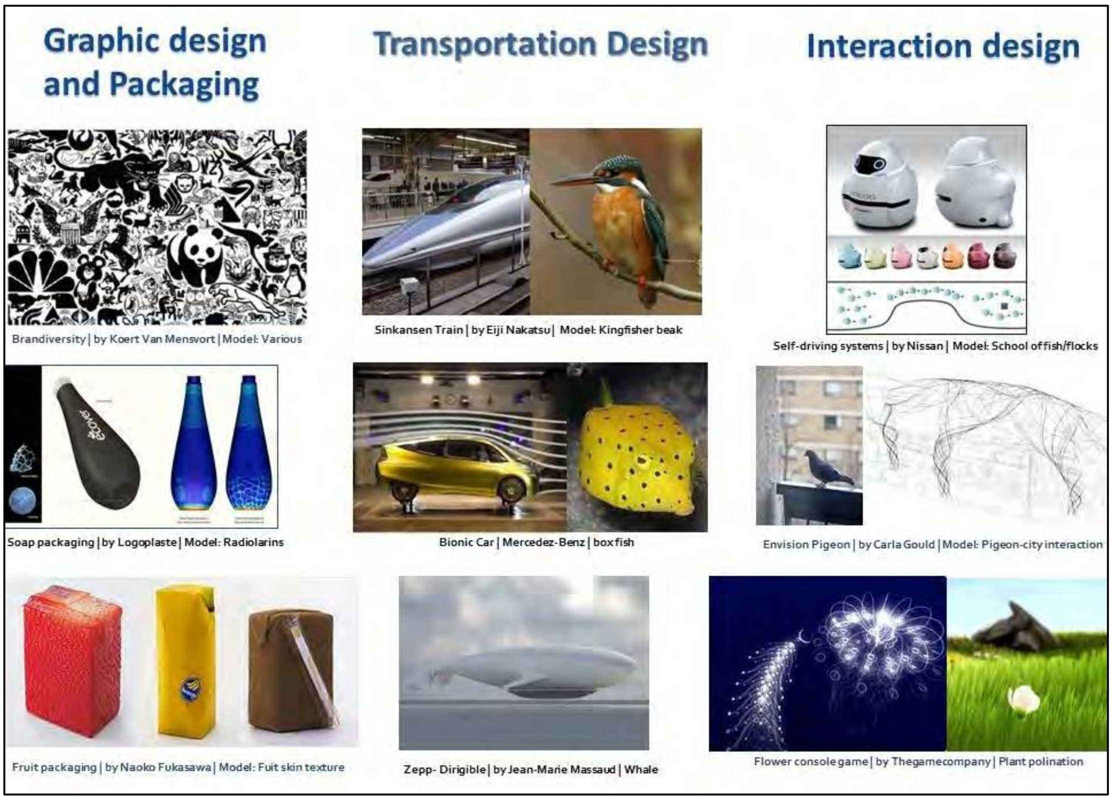
Appendix C.1 Contemporary Examples of biomimetic design

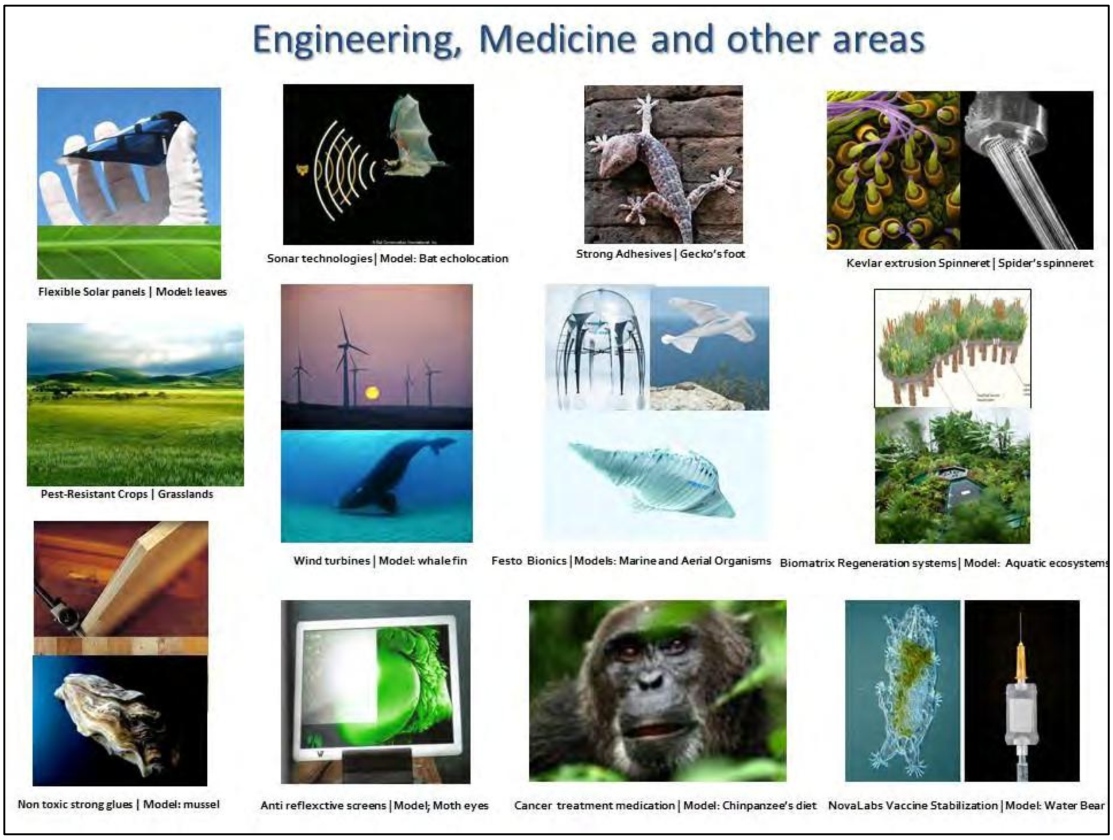





Interior/ Environmental Design
Lotus Effect Paint
By STO
Model: Lotus plant
Solar/wind facade
By Smit. Grow
Model: Ivy Plant
Place based interiors
By NatScape
Model: Desert Biome
HermitCrab House
By FNP Architects
Model: Hermit Crab
Bioluminiscent instalations
By Loop Ph
Model: Bioluminiscencent fish
Parasite House
Korteknie Architects
By: Parasitic Mushroom
Laren Building facade
By Monk Architects
Model: Boar Fur
Flower Pavilion
By London Design Fest
Model: Flower petals


Product Design
Bone Chair
By Joris Laarman
Model: Tree growth
Pax Volute water Pump
By Pax Scientific
Model: Vortes, Spirals
Sonar-Enabled Cane
By UltraCane
Model: Bat's Sonar
BioOrganic Designs
By Ross Lovegrove
Models: Various
Franco Lodato Design
By Franco Lodato
Model: Various
Cocoon Tents
By Various designers
Model: Coocons,
Chrysalis
BioInspired processes
By Nery Oxman/MIT
Model: Various
Invisible street light
By Jongoh Lee
Model: Tree branche
Owl Fan
By Silent Fan
Model: Owl
feathers
Luminaries 3Dp
By FOC
Models: Varios
botanics


Graphic design and Packaging
Transportation Design
Interaction design
Brandiversity | by Koert Van Mensvort | Model: Various
Sinkansen Train | by Eiji Nakatsu | Model: Kingfisher beak
Self-driving systems | by Nissan | Model: School of fish/flocks
Soap packaging | by Logoplaste | Model: Radiolarins
Bionic Car | Mercedez-Benz | box fish
Envision Pigeon | by Carla Gould | Model: Pigeon-city interaction
Fruit packaging | by Naoko Fukasawa | Model: Fuit skin texture
Zepp- Dirigible | by Jean-Marie Massaud | Whale
Flower console game | by Thegamecompany | Plant polination


Engineering, Medicine and other areas
Flexible Solar panels | Model: leaves
Sonar technologies | Model: Bat echolocation
Strong Adhesives | Gecko's foot
Kevlar extrusion Spinneret | Spider's spinneret
Pest-Resistant Crops | Grasslands
Wind turbines | Model: whale fin
Festo Bionics | Models: Marine and Aerial Organisms
Biomatrix Regeneration systems | Model: Aquatic ecosystems
Non toxic strong glues | Model: mussel
Anti reflexctive screens | Model; Moth eyes
Cancer treatment medication | Model: Chinpanzee's diet
NovaLabs Vaccine Stabilization | Model: Water Bear

Appendix C.2 Biomimicry Audio-Visual resources

Documentaries

Nature-Tech (Smithsonian Channel, 2008) Synopsis: Award winner documentary includes three episodes which focus on three key areas of investigation of biomimetics: Energy, Motion, and Materials. Episodes include:

- Magic of Motion: Shows the aerodynamics of how animals walk, swim and fly. All the Wright Brothers needed to do was look up...to the turkey vulture? Nature inspired man's earliest motion and continues to do so today.
- The Material World: Nature is full of amazing materials, tougher than steel and sharper than our finest optics, and uses them in extraordinary ways. Scientists look for materials that are warmer, smarter, stronger and more eco-friendly.
- Energy is the Key: Sunlight and plants, the alchemy of life. Human mastery of fire freed us from energy constraints, but at what cost? The search for new ways to live on our planet.

TV programmes

Miracles of Nature (BBC 2012). Synopsis: Richard Hammond reveals secret animal abilities from the natural world, and discovers how those same animals have inspired a series of unlikely human inventions at the very frontiers of science. Includes three episodes: Super-powers, Super-Senses and Super-bodies.[1]

*Related project examples for the 'Community' project:
Secrets of Our Living Planet(BBC, 2012) -a ground-breaking, global nature series with Chris Packham, showcases the incredible ecosystems that make life on Earth possible[2]
Nature's MicroWorlds(BBC, 2012) -Series in which Steve Backshall looks at some of the world's most iconic ecosystems.[3]
Wild Arabia (BBC, 2013) –Episode 3 clip: A hairy-footed, long-legged jerboa leaps 10 times its own body length to escape a desert fox.[4]

Online Presentations

Biomimicry in Action (TED talks, 2009) Janine Benyus has a message for inventors: When solving a design problem, look to nature first. There you'll find inspired designs for making things waterproof, aerodynamic, solar-powered and more. Here she reveals dozens of new products that take their cue from nature with spectacular results.[5]

Design at the intersection of technology and biology (TED Talks, 2015) Designer and architect Neri Oxman is leading the search for ways in which digital fabrication technologies can interact with the biological world. Working at the intersection of computational design, additive manufacturing, materials engineering and synthetic biology, her lab is pioneering a new age of symbiosis between microorganisms, our bodies, our products and even our buildings.[6]

[1] "Richard Hammond's Miracles of Nature - BBC One," *BBC*, accessed October 18, 2015, http://www.bbc.co.uk/programmes/b01nvn22.
[2] "Secrets of Our Living Planet - BBC Two," *BBC*, accessed October 1, 2015, http://www.bbc.co.uk/programmes/b01k73zy.
[3] "Nature's Microworlds - BBC Four," *BBC*, accessed October 1, 2015, http://www.bbc.co.uk/programmes/b01l2swt.
[4] "Jerboa's Great Escape, Sand, Wind and Stars, Wild Arabia - BBC Two," *BBC*, accessed October 18, 2015, http://www.bbc.co.uk/programmes/p013xzv4.
[5] *Biomimicry in Action*, accessed October 18, 2015, https://www.ted.com/talks/janine_benyus_biomimicry_in_action?language=en.
[6] *Design at the Intersection of Technology and Biology*, accessed October 18, 2015, https://www.ted.com/talks/neri_oxman_design_at_the_intersection_of_technology_and_biology.

Appendix C.3 Biomimicry Research Questionnaire

Workshop 2: Biomimicry (Research evaluation)

Do you think biomimicry can help society to:

( )Create a new aesthetic in objects
( )Organize communities and their ethics
( )Become a smart society
( )Save biodiversity
( )Solve energy use issues
( )change the concept of waste
( )All of the options

Did you understand the **life's principles** and **the design spirals**?
( )Yes   ( )No

Which templates did you find more useful to do research?:
( ) Need and context identification
( ) Ask Nature how? (Identifying species and its technical solutions)
( ) Biological empathy (drawing interviewing specie)
( ) Biological research (Doing research about selected species)

Which of these activities you enjoyed most:

( )Finding life's principles on natural objects/artificial objects
( )Biologising objects and Anthropomorphising elements
( )Homework about finding information about biological entity
( )Videos and presentations
( ) Chapter to read (Paintbrush shark)
( )All the activities

What biomimicry means to you?

____

Are you considering using Biomimicry theory and methods in future projects?
( )Yes ( )No ( )Depends the kind of projects

Why?____

9. Finally, what was your average experience in Workshop 2: Biomimicry?
(1= bad experience to 5 = excellent)

1   2   3   4   5

Appendix C.4 Schedule of a day session on Biomimicry

Workshop 2

Biomimicry: A way of design with nature

Description

Biomimicry, the conscious emulation of nature's genius (Benyus, 1997), has being present since humans were capable to understand and replicate the wisdom of the natural world. Animals, plants, bacteria, fungi and the exploration of our human body are bringing an innovative way to design technologies, acquire new aesthetics and to reinterpret clever strategies for human culture. The activities will set the second step towards an ethical way to co-create with nature.

Aims

- Reaffirm the fundamental smartness of biodiversity in creating conditions conducive to life.
- Understand that emulating living systems add intrinsic ethical values for our culture.
- Identify biomimicry and the method as a tool to achieve ecological designs and sustainable practices.
- Understand biomimetic designs as a meaningful way to *shape our communities* and their levels of integration with nature.

Agenda

9:30-10:00 Evaluation Workshop 1 | Review Reading

10:00-11:00 Presentation Biomimicry |Activity: Life's principles and values

11:00-11:30 Biomimetic design examples | Videos: Nature-Tech

11:30-12:30 Biomimicry Methods | Bioinspiration

12:30-1:30 Lunch

1:30-2:30 Video: Animal communities

2:30-3:00 Using the Biodesign methods / Biological Research

3:00-4:30 Team Reviews

Dundee Botanic Garden, 2-10-2014

Appendix C.5 Life's principles (from Biomimicry 3.8)

Appendix C.6 Life's Principles vs. Human Responses (adapted by Porritt)

Life's principles	Human Responses
Runs on sunlight	Runs on fossil fuels
Uses only the energy it needs	Wastes massive amounts of energy
Fits form to function	Forces to fit its own function
Recycles everything	Recycles next to nothing
Rewards Cooperation	Requires competition
Banks on diversity	Opts for monoculture
Demands local expertise	Demands global mobilization
Curbs excesses from within	Unlimited use of resources
Taps the power of limits	No limitations to produce it

Appendix C.7 Template 1

Template 1 | Biomorphise it / Antropomorphise it

Instructions:

- Identify an organism (or part of an organism) and a man-made artefact of interest
- List their environmental / social values
- Try to draw its artificial / natural analogue.
- Prepare to share with the class your findings

Organism	Man-made artefact
Drawing: Ecological values:	Drawing: Social Values (biophilic):
Anthropomorphise it (make it artificial or find a similar man made object)	**Biomorphise it** (make it as natural as possible or find a similar in nature)
Drawing: Social Values (biophilic):	Drawing: Ecological Values:

Appendix C.8 Template 2

Template 2 | Identifying the need

Instructions: Identify the need you are attempting to solve through design. The challenge is in the design brief. Conclude identifying the natural context and the design need to be solved.

Challenge	Focus	Natural Design Principle tick a box(es)			
Community	Housing	Form	Function	Process	System

A. Need identification
(Discuss with your group the needs we are facing. List them and select one)

	Focus		
Human	housing	needs:	- insulation - *ventilation* - prevent flooding - -
			Need Selected: Prevent Flooding

B. How needs have been solved?
(After selecting the need to tackle, identify the ways society have been solving such need)

	Focus + need		
How does human society solve	Housing flooding	needs?	- Bricks making - wall ventilation - thickness of walls - *protection barriers* -
			Selected solution(s): Protection barriers

C. Locate the design parameter:

(Mark the area where is located the need)

<table>
<tr><td>Information</td><td>Energy</td><td>Structure</td></tr>
<tr><td>Communication</td><td colspan="2">Material</td></tr>
<tr><td colspan="2">Behaviour/Control</td><td></td></tr>
<tr><td colspan="3">Space</td></tr>
<tr><td colspan="2">Time/Cycles</td><td></td></tr>
<tr><td>Sensors</td><td colspan="2">Processes/Mechanisms</td></tr>
<tr><td colspan="3">Genetics and other cultural aspects</td></tr>
</table>

D. Contextualise the problem

(Describe the problem we going to tackle)

<table>
<tr><th>Natural Context</th><th>Challenge</th><th>Focus</th><th>Natural Design Principle</th><th>Need Selected</th></tr>
<tr><td>Rainforest</td><td>Community</td><td>housing</td><td>System</td><td>Protect from flooding</td></tr>
<tr><td colspan="5">Quote Problem:

For the "rainforest" "community" we need a "Transportation" "system" that helps to "prevent flooding."</td></tr>
</table>

e.g. to express the problem: For the "rainforest" "community" we need a "Transportation" "system" that helps to "prevent flooding"

Appendix C.9 Template 3

Template 3 | Rediscover

A. Ask Nature how?
(Identify in the context selected the organisms who are more likely to solve the need)

	Context	challenge	Need selected	List of organisms:
Which?	Rainforest	communities	Prevent flooding?	- Frog eggs - Mangroves - - -
				Organism selected: Mangroves

B. Biologising
(Find synonyms and technical words based on the need you selected/identified)

	Need Identified	Synonyms and other technical words:
How does nature?	Prevent flooding	block water repels water

C. In what organisms you can find such feature(s)?

In what kind of plants?

In what kind of animals?

In what kind of fungi?

In what kind of bacteria?

In what kind of protozoan?

(After your research on these species, discuss in your group and select the potential one)

Appendix C.10 Template 4

Template 4 | Biological Empathy Map (original analysis)

Instructions: Interview the organism/ecosystem.

My common name:___________

My scientific name:__________

Life Level	Taxonomy
Molecule-Organelle-Cell-Tissue-Organ-System-Individual-Society-Ecosystem-Bioregion-Biosphere	Kingdom: _________ Phylum:_________ Class:________

How do you communicate with others?

Where do you live?

Which senses do you use the most?

How do you travel?

What do you eat?

How do you describe yourself?

How do you socialise?

How do you learn from others?

Why do you____________?

Original Illustration

What other information or stories you know about this organism?

What biophilic values you can identify about this organism?

Appendix C.11 Template 5

Template 5 | Biological Research

Instructions: On this sheet include sketches, pictures, word definitions and related data of the organism or parts of the organism selected. Note: You can add more pages if necessary.

Species' Scientific Name:_______________ Biological entity:_____________________	Design Parameter:_______________________ Technical words:_________________________	Life level: Page:
		Information Sources: (websites, journals, books, databases)

Appendix C.12 Template 6

Template 6 | Natural Prototyping

Instructions: From your biological research select one or two potential applications to be abstracted and added to your design concept.

A. Abstract your findings regarding the four natural design aspects.

Focus:
Need:

Forms	Functions
Processes	Systems

B. Develop your concept(s). You can add more features found in the organism or other organisms. You can go back to the template 2 if necessary.

Note: you can use your sketchbook

C. Enhance and evaluate your final concepts by reviewing nature's fundamental principles: Material life cycles, Energy sources, information feedback, etc. (see D. Checklist)

Final Concept:

Name of your concept:	

Context	Challenge	Focus	Need

Appendix D.1 Natural Effect/ Human Effects

Table.A Natural/Human tags

Natural Effect	Human Effect
Mountain	Spiritual Guide
River	Doctor
Woodland	Composter
Bee(s)	Ceramist
Fungi	Gardener
Lake	Musician
Rabbit(s)	Beekeeper
Soil	Constructor
Fish(es)	Hunter
Horse(s)	Weaver
Wheat	Farmer
Willow	Transporter
*add more as needed.	

Appendix D.2 Resilience Reflective Piece example

The Resilient Island

We were given the task of creating an island from soil & greenery found around the botanical gardens. We collected 6 flowerpots to bring back to the classroom and emptied their contents onto the table. After this we were each told to choose out of a list of natural phenomena – of which I chose woodlands. Using these labels we created the island whilst inputting our natural influence on the island. We began to put in woodlands, rivers, lakes, rabbits, bees, and flowers etc. depending on our label.

The influences showed us how each bit of the natural world depends on several other aspects. Therefore my woodlands were situated near the river and the lake on the island. After putting down the natural aspects, we were then given different social positions within the community and were told to place these social personas in a suitable part of the island. For example, I decided to place my spiritual guide on top of the mountain, as he was a central figure in the community that the people looked to for advice. Our island then suffered from a natural disaster in the form of an earthquake thus destroying most of our civilization. We reflected upon how our community had been built, particularly the location of the hospital in relation to the rest of the community.

After the destruction of our island we began to rebuild our community based on the earthquake analysis. I decided that the community should inhabit one side of the island (divided by the river). Thus in the event of another earthquake, the community would not be split by the natural boundaries. In the rebuilding of the community, I placed the hospital in a more central location, enabling easier access. During the rebuilding process we kept in mind the idea of a resilient community.

Mattew Hilley

Appendix D.3 Resilience Audio-visual Material

Documentaries

Economy of Happiness (2011, Helena Norberg-Hodge et al) Synopsis: Award-winning documentary film produced by Local Futures/International Society for Ecology and Culture (ISEC). Local Futures is a non-profit organization dedicated to the revitalization of cultural and biological diversity, and the strengthening of local communities and economies worldwide. Our emphasis is on education for action: moving beyond single issues to look at the more fundamental influences that shape our lives.

Easter Island: Mysteries of a Lost World (BBC, 2014) Synopsis: This film examines the latest scientific and archaeological evidence to reveal a compelling new narrative of the majestic Easter Island, one that sees the famous statues as only part of a complex culture that thrived in isolation. Dr Jago Cooper finds a path between competing theories about what happened to Rapa Nui to make us see this unique place in a fresh light.

From the Heart of the World (BBC, 1990) and Aluna (2012) Synopsis: The leaders of the Kogis, an ancient hidden civilization in South America show mankind how to avoid destroying the planet. In the first film the elders open the doors of their village to the BBC in the second they travel with an aging British film-maker Alan Ereira and four hundred kilometres of gold thread to trace invisible connections in nature.

YouTube clips/TED Talks

United Nations Decade on Biodiversity - Official Video (UN, 2011) Synopsys: The Decade coincides with and supports the implementation of the Strategic Plan for Biodiversity 2011-2020 adopted by the Conference of the Parties at its tenth meeting held in Nagoya, Japan. https://www.youtube.com/watch?v=zpM-nkhZCgk

Learning from a barefoot movement (TED, 2011) Synopsis: In Rajasthan, India, an extraordinary school teaches rural women and men — many of them illiterate — to become solar engineers, artisans, dentists and doctors in their own villages. It's called the Barefoot College, and its founder, Bunker Roy, explains how it works.

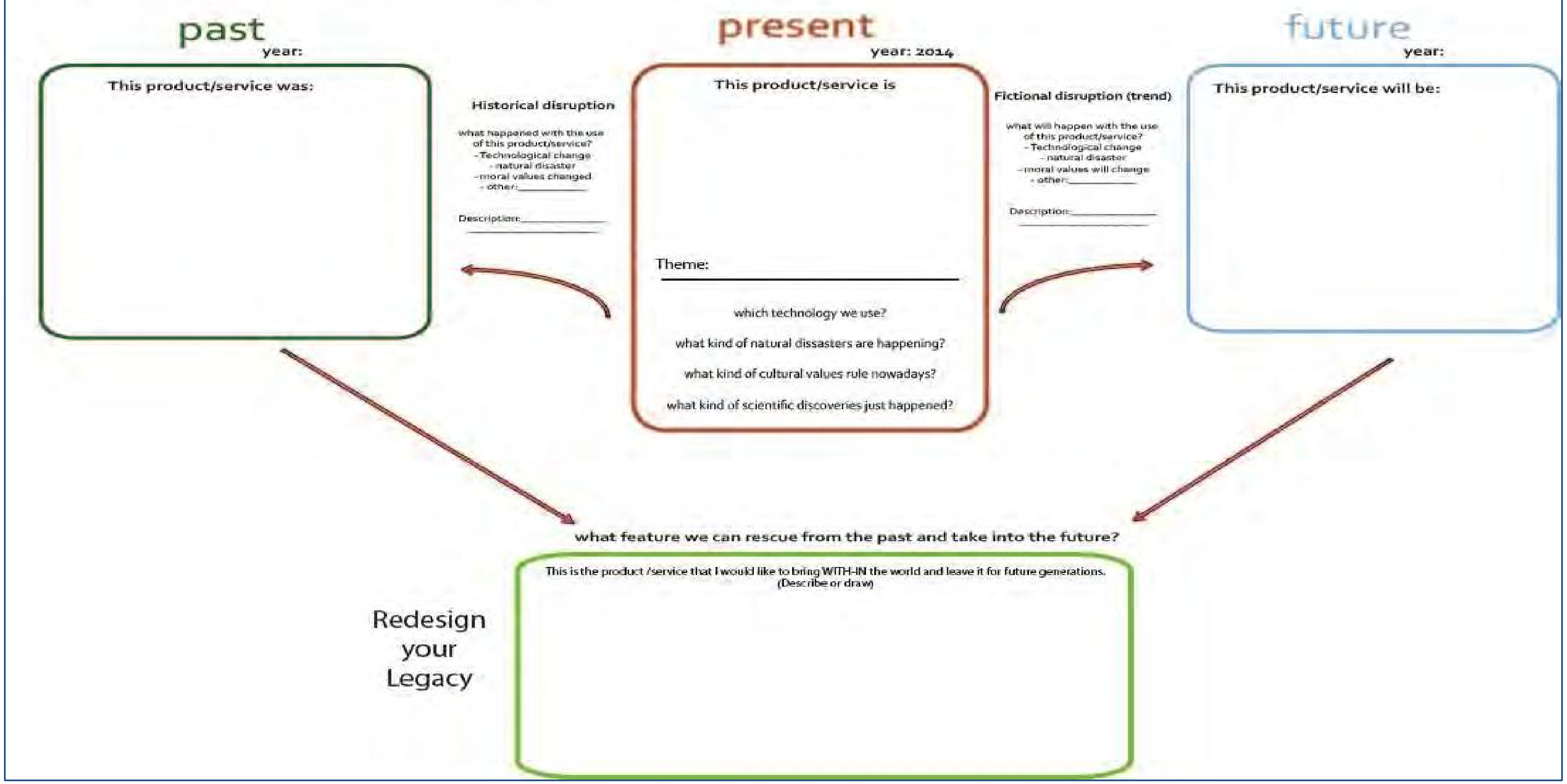
Rob Hopkins: Transition to a world without oil (TED, 2009) Synopsis: Rob Hopkins reminds us that the oil our world depends on is steadily running out. He proposes a unique solution to this problem — the Transition response, where we prepare ourselves for life without oil and sacrifice our luxuries to build systems and communities that are completely independent of fossil fuels.

Appendix D.4 Template 6. Forecasting (sample)

TEMPLATE 6

Forecasting

Instructions: starting in the present, identify a need/problem in your context. Go 10 years back into the past and using points or sketches illustrate the past, answer the questions in between and then imagine how how is going to be in the future asking the questions in between. Conclude in the actions you must take now to redesign or reframe your ideas. Redesign your legacy!



Appendix D.5 Example Schedule of a day session on Resilience

Workshop 3

The Resilient Community: A way to change along with nature

Description

Resilience is a concept familiar to the ecologist, it refers to the ability of a system, from individual people to whole economies, to hold together and maintain their ability to function in the face of change and shocks from outside (Hopkins,2008). When facing technological mistakes or natural disasters the human-nature dialogue appears, promoting resilience and linking individuals, communities or populations organically. This concept will bring the third step towards an ethical but natural rhythm, fitting and change our human intention along with nature.

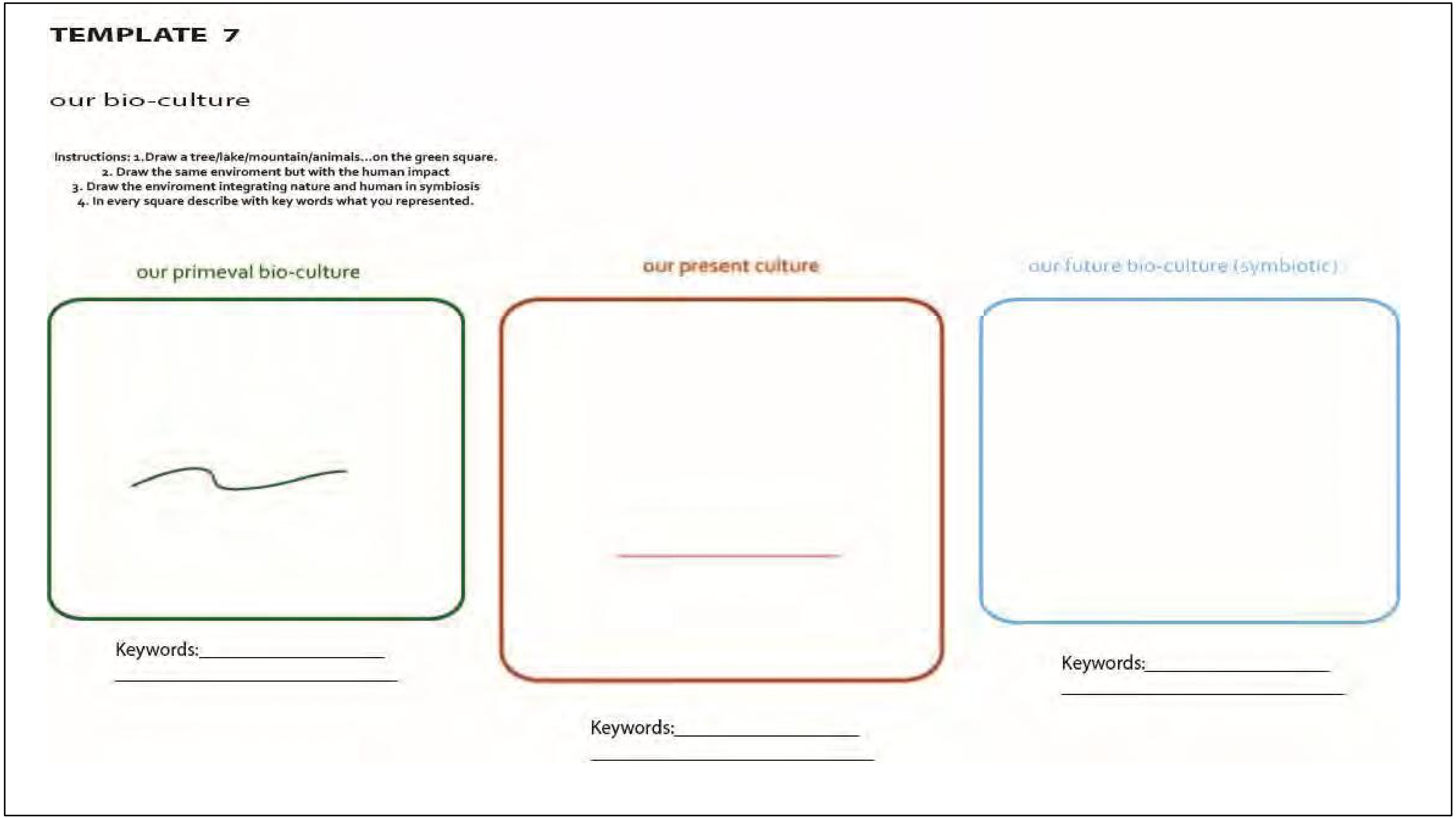
Aims

- Visualize resilience to facilitate ethical decision-making.
- The significance of systems thinking to acquire a holistic sense in our human endeavors.
- Develop a sense of coherence and humility about the creation of future scenarios.
- Acquire holistic ethical values promoting interdisciplinary learning and collaboration

Agenda

- **9:30-10:00** Presentation: Resilience
- **10:00-10:30** Activity 1: Making Natural effects (ecosystem)
- **10:30-11:00** Activity 2 : Interventions Cultivated system
- **11:00-12:00**Activity 3: Unexpected Event
- **12:30-1:15** Lunch
- **1:15-2:00** Games: Resilient web /video: interconnections
- **2:00-3:00** Activity 4: Forecasting
- **3:00-3:30** Designing resilient communities (group reflection)
- **3:30-4:30** Group reviews

Appendix E.1 Template 7, Our Bio-culture (Small version)



Appendix E.2 Symbiosis Audio-visual resources

Documentaries

Ecological Design: Inventing the Future (Christopher Zelov and Brian Danitz, 1994) Synopsis: Ecological Design: Inventing the Future is an educational documentary film that illuminates the emergence of ecological design in the 20th Century. The film features the ideas and prototypes of pioneering designers who have trail-blazed the development of sustainable architecture, cities, energy systems, transport, and industry. Beginning in the 1920's with the work of Buckminster Fuller, moving through the 1960's and the Counter Culture and ending up on the doorstep of the 21st Century, the film follows the evolution of ecological design from the visions of a few independent thinkers to the powerful movement it is becoming.

11th Hour (Leila Conners and Nadia Conners, 2007)Synopsis: With contributions from over 50 politicians, scientists, and environmental activists, including former Soviet leader Mikhail Gorbachev, physicist Stephen Hawking, Nobel Prize winner Wangari Maathai, and journalist Armand Betscher, Paul Hawken, the film documents the grave problems facing the planet's life systems. Global warming, deforestation, mass species extinction, and depletion of the oceans' habitats are all addressed. The film's premise is that the future of humanity is in jeopardy. The film proposes potential solutions to these problems by calling for restorative action by the reshaping and rethinking of global human activity through technology, social responsibility and conservation.

Human (Yann Arthus-Bertrand, 2015) Synopsis: HUMAN is a collection of stories about and images of our world, offering an immersion to the core of what it means to be human. Through these stories full of love and happiness, as well as hatred and violence, HUMAN brings us face to face with the Other, making us reflect on our lives. From stories of everyday experiences to accounts of the most unbelievable lives, these poignant encounters share a rare sincerity and underline who we are – our darker side, but also what is most noble in us, and what is universal. Our Earth is shown at its most sublime through never-before-seen aerial images accompanied by soaring music, resulting in an ode to the beauty of the world, providing a moment to draw breath and for introspection. HUMAN is a politically engaged work which allows us to embrace the human condition and to reflect on the meaning of our existence.

Short Clips

Papiroflexia (Joaquin Baldwin, 2007) Synopsis: Papiroflexia (Spanish for "Origami") is the animated tale of Fred, a chubby man with a passion for paper folding, who wants to change the world with his art. It was originally written as a poem by Joaquin Baldwin, and later developed into an animated film at the UCLA Animation Workshop, with music by Nick Fevola.

Metamorphosis (YouTube clip) synopsis: Clip that displays the life Cycle of the Monarch Butterfly (Danaus plexippus). You can show any clip that that shows the growing stages from a caterpillar feeding to pupation to enclosing from a chrysalis and then a butterfly. https://www.youtube.com/watch?v=0cWgSgMGxOc

Appendix E.3 Example Schedule of a day session on Symbiosis

Workshop 4

Symbiosis: A way to participating with nature

Description

Symbiosis, which in terms of biology means, an interaction between two different organisms living in close association, typically to the advantage of both (Margulis, 1991). This term will give us the final step towards the achievement of an ethical image of our future: where human intention and nature's intention work together. In order to conclude the series of workshops, we are going to integrate all the concepts (Resilience+Biomimicry+Biophilia+Symbiosis) to become complete *ethical designers*.

Aims

- Recognize a transition momentum towards a new ethic: co-creating with nature through design.
- Acquire the complete ethical values to re-imagine our culture towards a bio-culture.
- Review all the concepts and tools learned for our future practice as ethical designers.

Agenda

9:30-10:00 Review / Presentation: Symbiosis

10:00-10:30 Activity: Our bio-culture

10:30-11:45 Documentary: The 11th Hour

11:45-12:00 Connecting the dots

12:00-1:00 Lunch

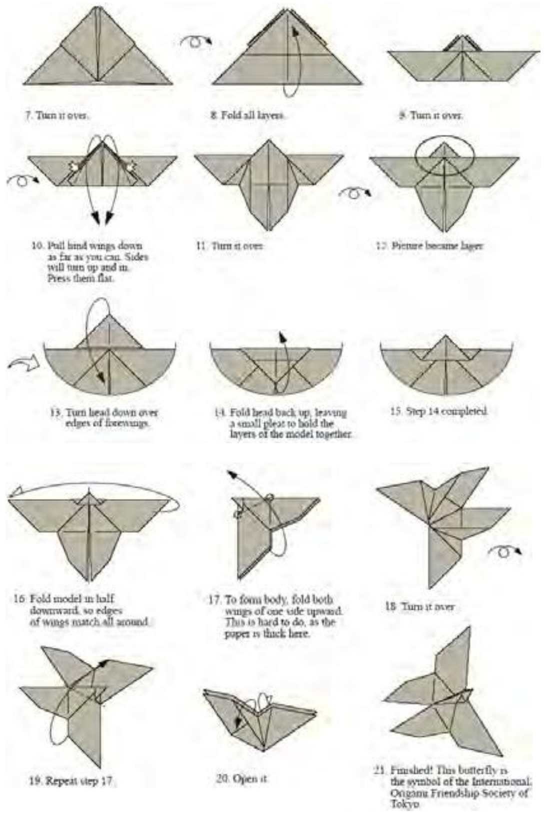
1:00-1:30 Metamorphosis activity | Short video: Origami

1:30-2:30 Presentations: Living communities.

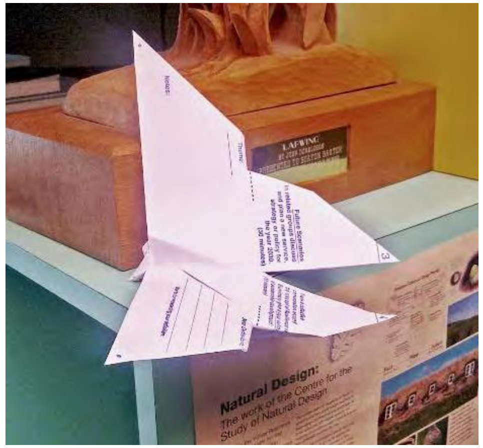
2:30-3:30 Teams Review

Appendix E.4 Template 8 Metamorphosis (folding steps by Akira Yoshizawa)

(Small version)



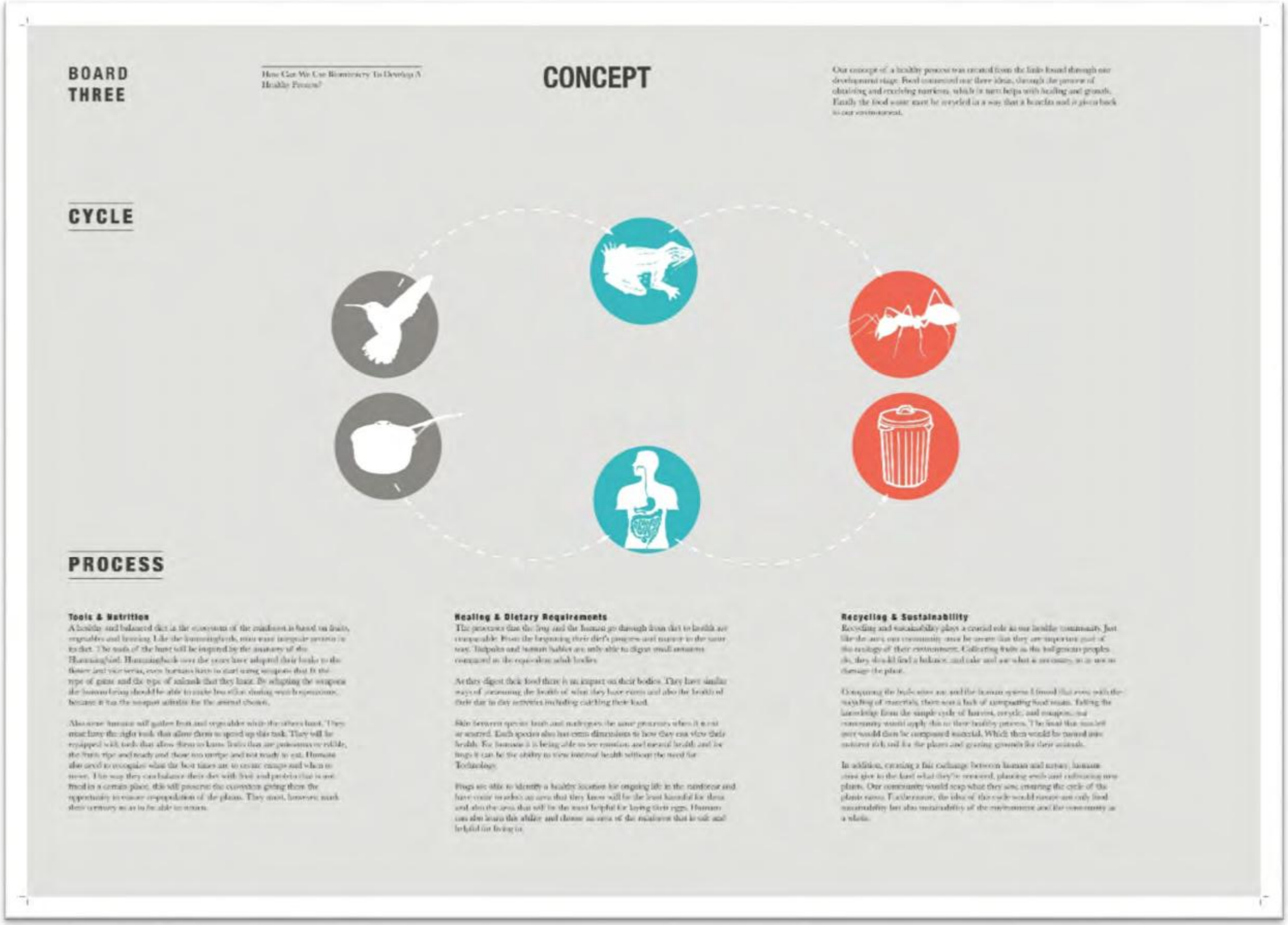
(Origami Steps)



(Finished exercise)

Appendix E.5 Learning Journey Example

Appendix E.6 Final Project presentation Examples



Appendix E.6 Final Project presentation Examples (continues)

Reflection

Design can change the world

The workshop with Prof. Seaton Baxter included a documentary entitled 'The Heart of the World'. It was a look at the in workings of the Kogi tribe. In one part the narrator described the traditional in which 'special' Kogi children are chosen at birth to become the future spiritual leaders of the tribe, and must spend the first nine year of their lives in a dark cave preparing for this responsibility. The outside world is described to them in great detail but they do not actually see it until they emerge from the cave. As a class we attempted to imagine the awe those children must feel the first time they see the forest, or the mountains, or the sunset.

This was an important moment for me in the course as it was a way to visually explain the wonder and respect for nature that must be reignited to understand the values of ethical design. I can remember that reverence and astonishment that I felt when experiencing nature as a child, but somehow that has diminished over the years. Even coming from a country that is famous for its natural landscapes, I need to reestablish the connection to the environment I live in.

Throughout this course I realised that I had been thinking of environmental issues and human issues as separate concerns. This project has demonstrated to me that they are not. Humans are not isolated or superior, we are as much a part of the ecosystem of our planet as any other animal. We rely completely on the natural world to survive, and as a species we have to appreciate this.

As am now finished my third year of university and will be returning home to undertake my major project in my fourth year, I think that this was a hugely valuable course for me at this time. The process of using natures designs as inspiration, through biomimicry, biophilia and symbiosis, as well as incorporating ethical design values into my design practice, will be truly influential on my choice of topic and the direction of my research next year.

This course has been challenging in parts. For some time near the beginning of the project I found it difficult being unsure of exactly what I was working towards as a final outcome. In the learning model that I am used to it is generally made very clear. However, I think that I actually learnt more because of this uncertainty. Because I were not always researching with a specific goal in mind I was able to explore and experience outside of what I thought I 'should' be learning. I was not just absorbing facts so that I could hand them back in the form of an assignment, but making discoveries that actually made me consider how, as a designer, I could bring about change. As a graphic designer I sometimes get frustrated as to what I can do, aside from using sustainable paper stocks, to benefit this planet in any tangible way, but this course has opened my eyes to the power that design has to influence and help both society and the natural world.

Design Values, Issues & Ethics (research survey)

Please can you take time to complete the following survey about the module Design Values, Issues & Ethics. It will only take a few minutes of your time but your feedback will be very valuable to us.

*Required

1. **1. How would you rate your learning experience on the module Design Values, Issues and Ethics? ***

   1 being low and 5 being high.
   Mark only one oval.

	1	2	3	4	5	
Low	⬭	⬭	⬭	⬭	⬭	High

2. **2. Has this module made you think differently about your own design practice? ***

   Mark only one oval.

   ⬭ Yes
   ⬭ No

3. **3. How valuable did you find the workshop on Biophilia (outdoor/green house exercises)? ***

   1 being not valuable and 5 being very valuable.
   Mark only one oval.

	1	2	3	4	5	
Not valuable	⬭	⬭	⬭	⬭	⬭	Very valuable

4. **4. Explain briefly what you feel you learned from the workshop by Professor Seaton Baxter.**

   ....

5. **5. How valuable did you find the workshop on Biomimicry (learning from nature exercises)?** *
1 being not valuable and 5 being very valuable
Mark only one oval.

	1	2	3	4	5	
Not valuable	◯	◯	◯	◯	◯	Very valuable

6. **6. How valuable did you find the workshops with Dr Keith Skene?** *
1 being not valuable and 5 being very valuable
Mark only one oval.

	1	2	3	4	5	
Not valuable	◯	◯	◯	◯	◯	Very valuable

7. **7. Did you find it helpful to have a biologist contributing to the design process?** *
Mark only one oval.

◯ Yes
◯ No

8. **8. How valuable did you find the workshop on Resilience (island exercise/resilient web)?** *
1 being not valuable and 5 being very valuable.
Mark only one oval.

	1	2	3	4	5	
Not valuable	◯	◯	◯	◯	◯	Very valuable

9. **9. How valuable did you find the final reflective workshop on Symbiosis (Bioculture/origami exercise) ?** *
1 being not valuable and 5 being very valuable.
Mark only one oval.

	1	2	3	4	5	
Not valuable	◯	◯	◯	◯	◯	Very valuable

10. **10. What do you feel the workshops and lectures gave you?** *
Tick all that apply.

☐ A sense of curiosity and discovery (enchantment with the natural world)
☐ A sense of reconciliation between human's and nature's purpose
☐ Awareness of what you are going to leave for future generations and our world
☐ A new way to see and act in the world in which I live.
☐ A new way to design.
☐ Other: ______________________________

11. **11. What are the key themes you feel you will take back to your own design practice?** *
Tick all that apply.

- [ ] Biophilia (related to ecology and personal rediscovery)
- [ ] Biomimicry (related to bio inspired design values)
- [ ] Resilience (related to designing for a living planet)
- [ ] Ethics (related to design consciously for others, including non-humans)

12. **12. In terms of group experience, which of the following things did the module cultivate in you?** *
Mark only one oval.

- ◯ Work in teams
- ◯ Knowledge exchange
- ◯ Better quality of projects
- ◯ A wider understanding of the potential of design inspired by nature
- ◯ Other: ....

13. **13. In terms of individual experience, which of the following things did the module cultivate in you?** *
Mark only one oval.

- ◯ To rethink my design intentions professionally
- ◯ To see the world from different perspectives
- ◯ To explore biophilia, biomimicry, resilience and symbiosis through further studies
- ◯ An understanding of nature working with design
- ◯ Other: ....

14. **14. Do you feel it would be possible to complete this module in less than one day a week?** *
Mark only one oval.

- ◯ Yes
- ◯ No

15. **15. Can you please provide some comments relating to your learning journey on this module?** *

....
....
....
....
....

sr.dave.id@gmail.com

Edit this form

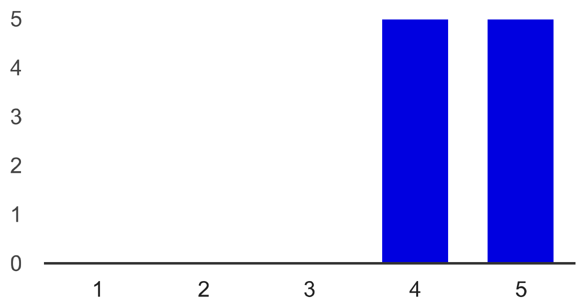
10 responses

View all responses   Publish analytics

Summary

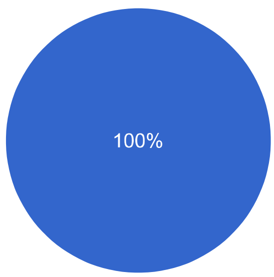
[Image]

1. How would you rate your learning experience on the module Design Values, Issues and Ethics?



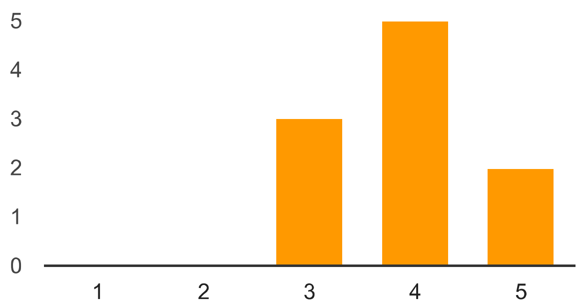
Low: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**5**	50%
High: 5	**5**	50%

2. Has this module made you think differently about your own design practice?



Yes	**10**	100%
No	**0**	0%

3. How valuable did you find the workshop on Biophilia (outdoor/green house exercises)?



Not valuable: 1	**0**	0%
2	**0**	0%
3	**3**	30%
4	**5**	50%
Very valuable: 5	**2**	20%

4. Explain briefly what you feel you learned from the workshop by Professor Seaton Baxter.

how to appreciate nature

That we need to start designing what we need and not for the sake of it

That nature will affect every piece of our lives and everything will do will affect mother Nature.

umm, a lot? i learnt that i know so little and that there is a welth of knowledge out there that i can't wait to learn. he opened my eyes to a lot of things.

what we percieve as happiness - U parabola, About morals - not taking what you don't need

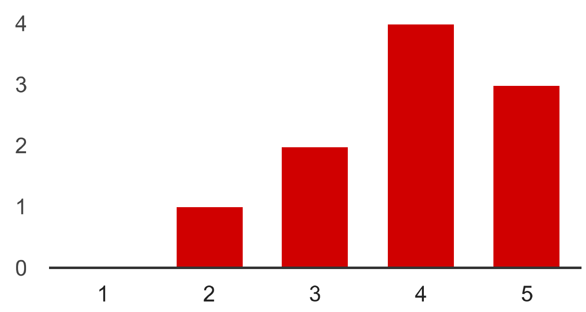
How to look through an image & what humans values are today

A new way of looking at life. It did alot to me, i'm very gratefull i met him

To reach an other point on the parabol you always need to travel thru a deeper/worse point

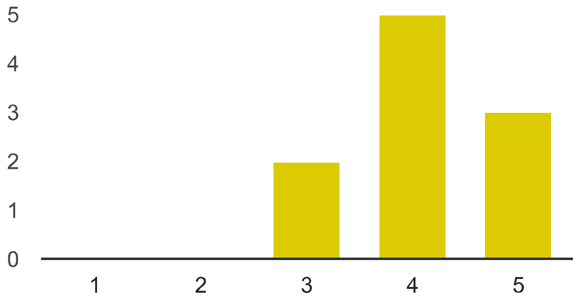
Not to be so pessimistic and also to appreciate how wonderful our world truly is!

5. How valuable did you find the workshop on Biomimicry (learning from nature exercises)?



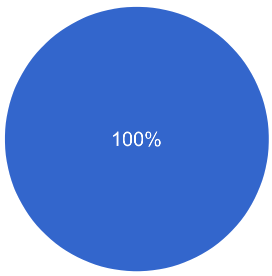
Not valuable: 1	**0**	0%
2	**1**	10%
3	**2**	20%
4	**4**	40%
Very valuable: 5	**3**	30%

6. How valuable did you find the workshops with Dr Keith Skene?



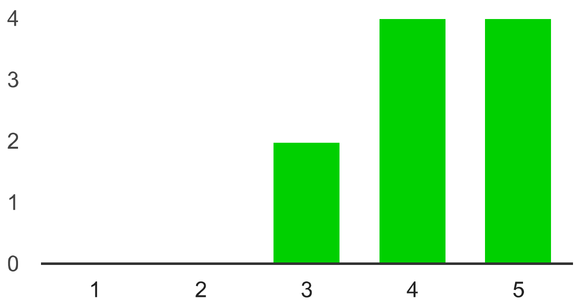
4	**5**	50%
Very valuable: 5	**3**	30%

7. Did you find it helpful to have a biologist contributing to the design process?



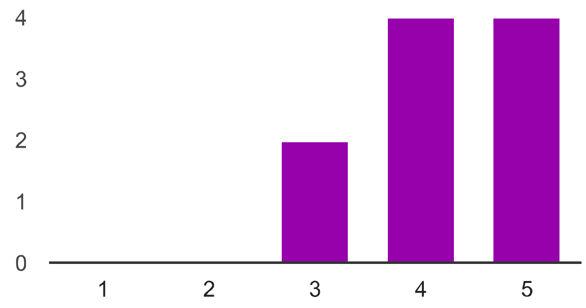
Yes	**10**	100%
No	**0**	0%

8. How valuable did you find the workshop on Resilience (island exercise/resilient web)?



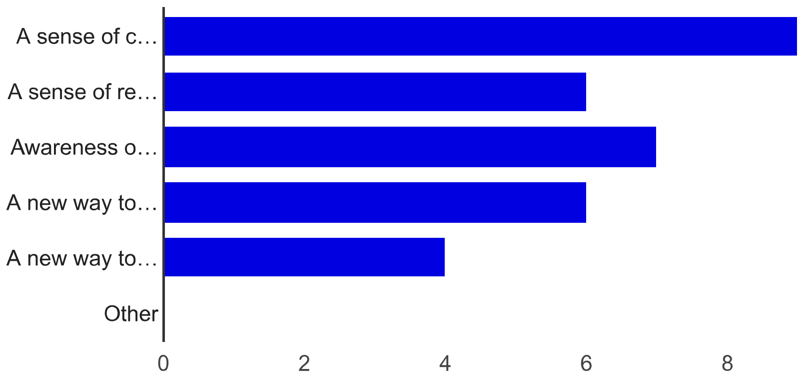
Not valuable: 1	**0**	0%
2	**0**	0%
3	**2**	20%
4	**4**	40%
Very valuable: 5	**4**	40%

9. How valuable did you find the final reflective workshop on Symbiosis (Bioculture/origami exercise) ?



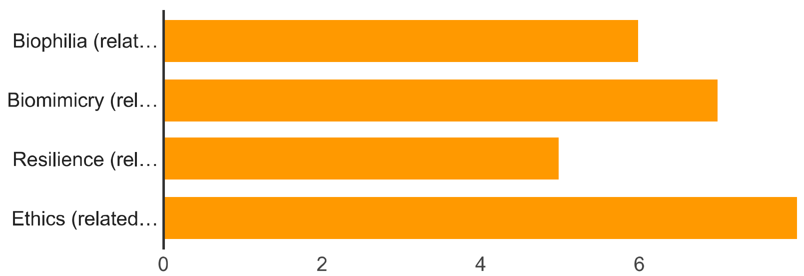
3	**2**	20%
4	**4**	40%
Very valuable: 5	**4**	40%

10. What do you feel the workshops and lectures gave you?



A sense of curiosity and discovery (enchantment with the natural world)	**9**	90%
A sense of reconciliation between human's and nature's purpose	**6**	60%
Awareness of what you are going to leave for future generations and our world	**7**	70%
A new way to see and act in the world in which I live.	**6**	60%
A new way to design.	**4**	40%
Other	**0**	0%

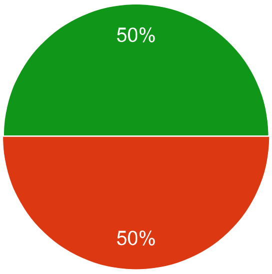
11. What are the key themes you feel you will take back to your own design practice?



Biophilia (related to ecology and personal rediscovery)	**6**	60%
Biomimicry (related to bio inspired design values)	**7**	70%

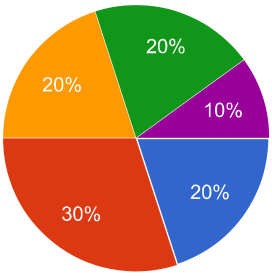
Resilience (related to designing for a living planet)	**5**	50%
Ethics (related to design consciously for others, including non-humans)	**8**	80%

12. In terms of group experience, which of the following things did the module cultivate in you?



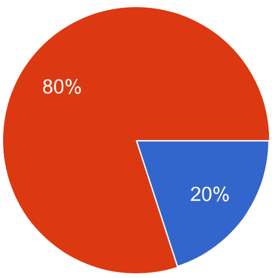
Work in teams	**0**	0%
Knowledge exchange	**5**	50%
Better quality of projects	**0**	0%
A wider understanding of the potential of design inspired by nature	**5**	50%
Other	**0**	0%

13. In terms of individual experience, which of the following things did the module cultivate in you?



To rethink my design intentions professionally	**2**	20%
To see the world from different perspectives	**3**	30%
To explore biophilia, biomimicry, resilience and symbiosis through further studies	**2**	20%
An understanding of nature working with design	**2**	20%
Other	**1**	10%

14. Do you feel it would be possible to complete this module in less than one day a week?



Yes	**2**	20%
No	**8**	80%

15. Can you please provide some comments relating to your learning journey on this module?

it was very good, and it is an experience that students who want to make a difference that should try.

I missed the workshop on biomimicary however i found the references to it in class and my own research extremely valuable. On question 14 however i don't feel that it would be possible to complete this module in less than one day a week due to feeling the need to connect what we learnt to other things. I feel that having 6 days gap between each class is too much and i feel that this module would work better over a less weeks with classes every day or more frequently.

At first, I did not know what to expect for this module but then after the workshops (Biophilia, Biomimicry, resilience and symbiosis) and the informative presentations from Seaton Baxter and Keith Skeen, I realise that all the knowledge was given to my to grasp on the idea on how to design with nature. I also enjoy the workshops with games in it. It was easy to remember the concept as it had a fun way of memorising it. I also like how David was very clear with his workshops and presentation. My over all experience was very good, coming from a graphic design background I was very surprise how much knowledge I gain, and be able to apply it to work and every day life.

well, at first all the information about how we are destroying our world was rather overwhelming and i wanted to run off + leave this planet, but over time as the weeks progressed I realised that there was something that i could actually do that would make a difference to this world and other people, and as a designer it was not only a privilage to be able to, but something that I was morraly responsible for. that i had to, and to not would be the greatest disrespect to my planet and those liveing on it. I have this opertunity and I must grasp it. this course has given me the tools to do so. Thank you so much! :)

I think that at the beginning it can be quite confusing, I would rather that the workshops at the beginning were explained a bit before setting out to do them, so that I could understand better, instead of it clicking afterwards. I think that the group project lended itself better towards product design/interaction design students, as they seemed to understand the way to deliver the brief and the process of how we should design better/people said they had done previous or similar projects to do with sustainability.It would be good if there was a way that Illustration/Graphics/Animation students could know a bit more about how they can take what they have learned back into their discipline. I liked the mix of practical and theory.

The videos were full of information which helped to keep it visual/ relatable. I liked the relevance of knowing what already exists in the world- I dindt have this knowledge and I dont think its easily available to it was nice to show this.

The days were long, but very interesting and helpfull. the assignment was challeging and we had enough time to work on it in class. Think overall everything went very well. Maybe the 2hour lunchbreak was a bit to long sometimes

The Goethean method was a real eye opener for me. Biomimicry was for me the most interesting of all 4. I think that is the one I will use the most in future. But you also need the other 3. When you want to design in a good ethic way, you need to combine all 4 points

I enjoyed it. Sometimes found the path that we were taken to our community designs very confusing and circular. I would rather have known what we were to do at the very start than to choose one thing then develop that and then be told to change it again and again. I really really enjoyed the talks by Seatton and Keith.

I really liked all the knowledge and ideas we learnt about . The new ethic . But I feel that through out the project it wasn't made very clear what I was suppose to create or present as a final outcome but I enjoyed the learning experience and outcome I produced

Number of daily responses