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# Spatial design thinking in the age of multimedia

Chuan Gao

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Spatial Design Thinking in the Age of Multimedia

By

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College of Technology

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for the degree of

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Abstract.....	iv
I. Introduction.....	1
A. General background for the study.....	3
B. Statement of Problem.....	4
C. Guiding Question.....	4
D. Limitations.....	6
E. Significance of the study.....	6
II. The review of the related literature.....	8
A. The definitions and rethinking the physical subject of space design.....	8
B. Definition: Architecture (design), Interior Design and Landscape Design.....	10
1. Architecture (design).....	11
2. Interior design.....	11
3. Landscape design.....	13
C. Method: method and process.....	13
1. Definitions of design method and relevant term.....	13
2. Popular space design method.....	14
III. The subjects of design users and goals for space deign are multifarious and has been changed.....	20
A. The subjects of space design users and goals for space deign are multifarious.....	20
B. The subjects of space design users and goals for space deign have been changed.....	25
C. Distinguish physical and psychology goals for space design.....	29
IV. Spatial design thinking and scientific research.....	31
A. Design methods can be mix to build a new design process and thinking map.....	33
B. Design elements and achievement.....	41

C. Creative in space design (neurology).....	43
V. Multimedia design theory.....	50
A. Comparing design elements and design method.....	51
B. Fractal and chaos theory for visual.....	52
VI. Finding: spatial design thinking and software support.....	61
A. Prezi as a basis, due to its characteristics.....	63
B. Prezi in spatial design.....	67
VII. Advantages of Spatial design thinking and Tool.....	73
A. Relationship to literature and theory.....	73
B. Relationship to practice.....	73
1. Material collection and communication feedback between user and designers.....	74
2. Better creation through perspective of designers.....	75
VIII. Discussions and Conclusion.....	75
References	
Appendixes	

## **Abstract**

There are several emerging design methods and design thoughts, such as Evidence-Based design, Universal design, and so on, that have been utilized in spatial design. Further, the space design has been changed in the wake of invention of new materials, building technologies, and users' functional needs. Designers need to collect and reorganize a new spectrum of information in order to conduct design. Designer's thinking power plays an important role in creating space. Base on the research results in the realm of human cognitive faculty, synesthesia may hold the key to understanding a mechanism for thinking, cross-sensory perception and association involved in artistic and spatial creation. In addition, multimedia is the acting edge tool to support design methods and design thinking. Mathematical model can also be used for explain space design generation and design thinking. As a result, Chaos theory and Mandelbrot Set can be used to support new spatial design thinking and design models. Finally, this study examines Prezi, a multimedia-based tool, to integrate design thinking and communication.

**Key words:** Spatial design, designers, Design method, Design thinking, Design thinking process, Synesthesia, Chaos theory, Generation Y , Multimedia, Prezi

## **I. Introduction**

There are several design methods used in interior design and spatial design, such as Evidence-based Design (EBD), The Integrated Design Process (IDP), Archer's model of the stage of a design process, and so on. All the design methods are used in different design projects because each of them has their own advantages. For example, Evidence-based Design (EBD) is a process for the conscientious, explicit, and judicious use of the current best evidence from research and practice in making critical decisions, together with an informed client, which is about the design of each individual and unique project (Hamilton, Watkins, 2009).

Evidence-Based Design took place on the health care environment design, school design, workspace environment design, and other public space because the methodology was developed from the evidence-based medicine system. Using correct design method(s) for a project is helpful to build a safe and efficiency space environment for users' physical needs and psychology needs. According to the research from United States Environmental Protection Agency (USEPA), it reports that there is about 90 percent Interior Designers on average from Americans (United States Environment Protection Agency/ Office of Air and Radiation, 2001). The number grows up to 40 hours per week for children to stay in school buildings, especially while they are participating in the after-school activities (Healthy Schools Network, 2012). It is more important to develop designers' job, and selecting the most appropriate design method has become an important issue for the designers.

At the same time, the subjects of design users and goals for space design are multifarious and these subjects have been changed. Design methods are supposed to adapt the new generation ranges from the year of 1981 to 2000; and the users whose age is from 11 to 33 will become the main part of workspace environment users and have their own space. The Generation Y has their individual characters and habits. A good spatial design project should work for both physical part and psychological part, no matter the change in economy and technology. Throughout the research, new visual design method is the primary method to be discussed in this paper. It can be used for individuals and commercial programs; as well as the process and order of thinking is logical and useful to reflect human needs and personalities.

The Four typology of Design Models (Blessing, 1994, Figure 1) shows four design methods by Blessing in 1994. The models are also respectively corresponding to the popular space design methods. The book, *Design Method* by John Chris Jones, listed three needs for methods. There are original work which appears for users, the solution to a difficult problem or transferring some simple methods to solve problems, and using creative imagination to overcome rigid origin.

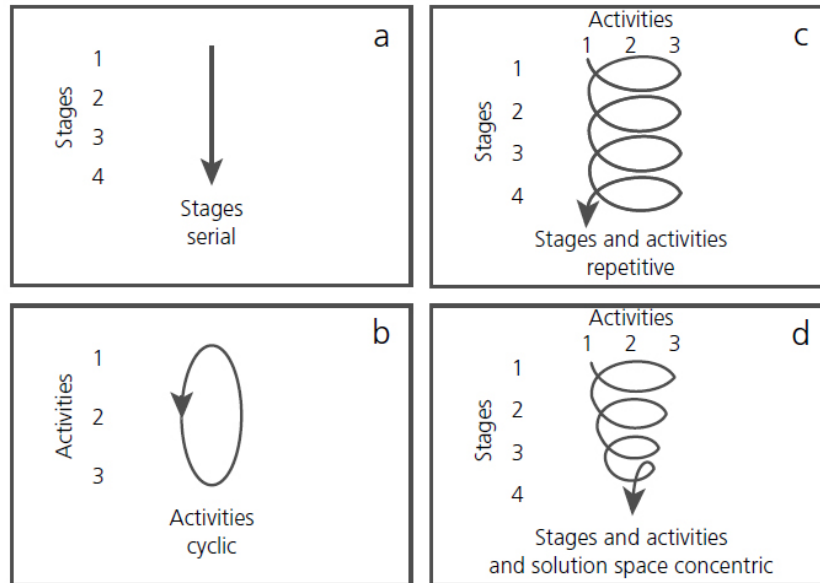


Figure 1, Four Typology of Design Models (Blessing, 1994)

#### A. General background for the study

There are several hot topics in my major of interior design, such as Universal Design, Evidence-Based Design, Green Design, Health-care Design, and so on. First, interior design is a part of space design because interior designers need to consider all space elements while designing a project. Such as, outdoor view, sunlight, climate and so on. Second, interior designers more consider physical not only conditions, but also pay attention to the psychological and spiritual level.

In interior design and space design, those trendy topics show relativities with technique, design method, and psychology. Designers often use techniques on sustainable buildings. The sustainable topic also shows a deep thinking, which is the future of human society. U.S. Green Building Council is one of the well-known professional organizations that primarily focus on



green building development. It has many branches around the world. Besides USGBC, there are many other organizations that are doing the same thing, such as the Cascadia Green Building Council (CGBC) and the Center for Sustainable Design (CFSD). No doubt, green building is a growing field in today's society and has been studied by thousands of scholars in different academic fields. *Evidence-based Design for Multiple Building Types* (Hamilton, K. & Watkins, H., 2009) is a book that explains new design methods. Many designers start to get a license for evidence-based design. In the evidence-based design, the topic use the best available knowledge to improve space design in architecture and interior design, and the knowledge is also the evidence that include entire theories and findings.

#### B. Statement of problem

In the spatial design field, designers can use a large number of design methods. For example, Iconic Design Process (Rowe, P, 1987) is a linear stage-based chronological structure. Evidence-based designs are the single stage series. These methods are feasible, but there are several conflicting aspects among them. Therefore, designers need an integrated design approach to integrate these existing design methods, and it also needs to adapt to change needs and uses. Some spatial design methods will be combined and used because they are depended on current diversity spatial design purposes and situations. Is synesthesia the key to build a mechanism for (cognitive) association and (artistic/spatial) creation?

#### C. Guiding question

Evidence-based Design (EBD), Integrated Design Process (IDP) and other design methods are becoming the popular topics in Interior Design. Evidence-based Design (EBD) is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, which are together with an informed client that about the design of each individual and unique project (Hamilton, Watkins, 2009). At the same time, the Iconic model of a design process is also a main method in spatial design. The Iconic model is used to distinguish two directions in the design process that an area vertical direction involves a sequential phasing of activities and a horizontal direction involves in the decision-making cycle. It will build a form called "iconic model" by Mesarovic in a way of gathering four main design elements, analysis, synthesis, evaluation and communication, in two directions (Rowe, P, 1987, Figure 2).

"Back to the things themselves" (Bell, A., 1990). this philosophical principle is a quote from Husserl that provides the philosophical foundation for this paper to rethink the spatial design method. A good spatial design project should work for both physically and psychology, independent from the change in economic and technological. Throughout the research, the primary method is the multiple design visual method which is discussed more than other every single design method used in this paper. The research explains a new and comprehensive vision of designers and architects who can both consider logical design methods and control the whole design process. Due to it can be used for individuals and commercial programs, further, the

process and the order of thinking are logical and useful in reflecting human needs and personalities.

#### D. Limitations

The design methods conceived by the institute tend to follow that it is feasible for the young designers and users to design a relatively private space for a public building. Moreover, the design method may only apply to the part of the young designers, because it is impossible for all designers to quickly grasp the main points. Some older designers may still consider in accordance with their usual design ideas, because they have become accustomed to a familiar way of thinking and it is difficult to change. Perhaps a new design approach will bring some limitations. For example, a large number of people prefer to reject the new technologies because of the different cultural background which can affect design thinking. The application of this design approach is in line with the trends and needs of the times. The research explains a new and comprehensive vision for designers and architects who can both consider logical design methods and control the whole design process.

#### E. Significance of the study

The economic development, cultural development, technology development, world revolution, as well as all the developments and changes bring various changes to space design goals and needs for the both physical field and psychological field. In addition, the Generation Y will become the main part of workspace environment users and these users have their own space.

The Generation Y has their individual characters and habits. These developments and changes will continue and provide designers more challenges in the future. Therefore, a design method researches that it is important and conducive for new space design and construction to both fit to the younger generation and use new technology. Not only the new design method can be visualized, but also the basic design logic can be reflected by the new design method. Their characteristics of visualization and intelligence can connect with each other and meet the requirements for the new generation designers. Based on the knowledge of visualization, there are more outcomes which are beneficial to be made through multimedia. Thus, there is more inspiration to be generated to help designers while they are lacking ideas.

The mix of complex design methods shows more choices than a linear design process, and fits design tasks that might have more than one correct answer. The important part of my study is to understand the deeper purpose of spatial design, and to create a design method that not only fits the needs of designers, but also works better than a single design method. Design method is a process to balance all design elements. Such as, a good physical environment will have a positive effect on users. This research will analyze several popular design methods and combine other researches focused on design and creativity that these researches are from the sociology and neurology fields; it will also explain a new method and relevant tools. The multiple spatial design method will help clients build their own space, as the qualities of interior context affect people's feelings, emotions, experiences and lives. According to the research from United States Environmental Protection Agency (U.S.EPA), on average, Americans spend about

90 percent of their time indoors (United States Environment Protection Agency/ Office of Air and Radiation, 2001). For children, the number goes up to 40 hours per week in school buildings, especially when they participate in after-school activities (Healthy Schools Network, 2012). To create a healthy environment, interior designers' role is getting more and more important.

## **II. The review of the related literature**

### **A. The definitions and rethinking the physical subject of space design**

General space design environment includes exterior, interior and virtual space. Interior design is not only for indoor space, but also requires designers to consider and balance all the elements for the indoor space and the life styles of the users. Different people have different definitions on the word "space". In architects' and interior designers' visions, space can be divided into several parts, but those separate parts are related to each other. Exterior (outdoor space), interior (indoor space), and virtual space are the main components of space category. Integrated design process (IDP) is the design method which tends to rebuild a relationship for all the design elements in a project, and the rebuilding will produce an effect of that one plus one is greater than two.

Exterior space is a part of the living environment. Usually, people have a generalized understanding about outer surface or the parts of exterior spaces, which include garden, playground, park, street, parking lots. Interior space is the inside part of the building, which include single room, space that has cover, and the pictorial representation of a room. More

frequently, people have a longer term and more comprehensive experience for interior space, which includes rooms that people use in their daily lives. For example, offices for work, classrooms for study, bedrooms for sleep. Bryan Lawson uses a "tree" to explain the relationship about urban design, architecture, interior design, and others (Figure 2, Lawson, B., 1990). The "tree" shows an inseparable relationship of spatial design for architecture, interior design and so forth. These spatial design fields involves in an indispensable and interdependent relationship. From the perspective of spatial design practitioners, we can get the same results. Many designers are engaged into two or more than two spatial design field works. For example, Zaha Hadid engaged into architecture design, interior design and product design.

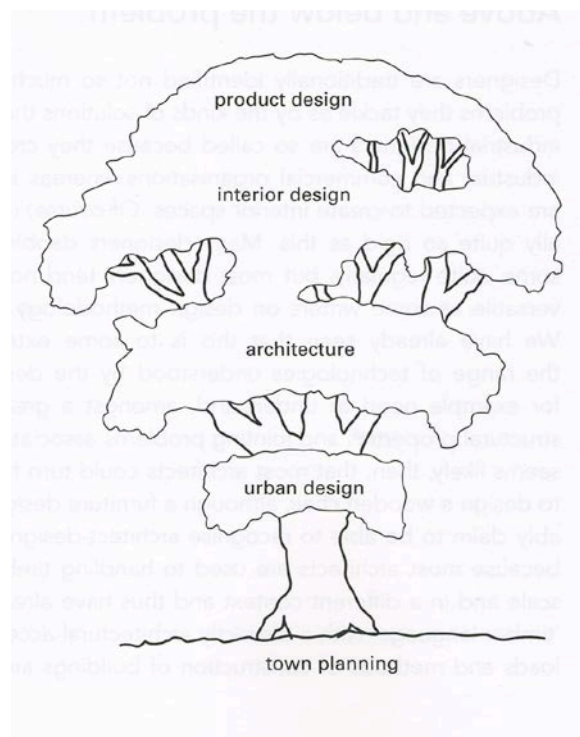


Figure 2, a "tree" of three dimensional design fields (Lawson, B., 2006)

Virtual spaces are a concept that also appears in people's lives every day, and it is the term that designers always use in their work. It has several meanings and being utilized in our real life. Virtual space could exist in people's mind. Designers use furniture, carpets and lighting to segment a big room into individual virtual spaces that can be well used. For example, virtual space is a feeling that people know transfer space and waiting space in a lobby. People's experience and environment can make a great impact on the feeling of the virtual space. For example, Otaku, a new Japanese term refer to people who obsess indoor setting, shows a new space sense in human mind that works with human sense.

In real life, exterior, interior, and virtual spaces always work together to create the space feeling, and most users are involved in the stage of urbanization. For example, a window is the object that connects indoor and outdoor. Users may mistakenly think a virtual space means a game map or other Internet websites.

#### B. Definition: Architecture (design), Interior Design and Landscape Design

Architecture is the general explanation for all the buildings and structures that are used by people every day and is comprised of several design fields. There are Architecture (design), Interior (architecture) Design, Landscape (architecture) Design, Environmental design, and some others forms of design. The multiple spatial design method mainly focuses on architecture and interior (architecture) design, even though landscape (architecture) design shows some aspects of space design's characteristics about the nature environment. Calvin Straub uses "Related Design Development" to explain Landscape and site development, interiors, finishing, equipment, and so

forth in an architect's view which is displayed in his book, *Design Process & Communications: a case study* (Straub, c., 1982).

## 1. Architecture (design)

Although it is hard to define the word architecture (design) because the definition of architecture is limited in a range by characteristics, the approved definition of architecture (design) in Oxford dictionary of architecture is as follows:

Architecture might be described as the art and science of designing a building having qualities of beauty, geometry, emotional and spiritual power, intellectual content and complexity, soundness of construction, convenient planning, many virtues of different kinds, durable and pleasing material, agreeable coloring and decorations, serenity and dynamism, good proportions and acceptable scale, and many mnemonic associations drawing on a great range of precedents (Curl, J. S, 2000).

Architecture is concerned with the creation of order out of chaos, a respect for organization, the manipulation of geometry, and the creation of a work in which aesthetics play a far greater role than anything likely to be found in a humdrum building(Curl, J. S, 2000).

## 2. Interior design



The definition of interior design is very helpful for designers to understand their work better. National Council for Interior Design Qualification (NCIDQ) defined the official meaning of Interior design as:

Interior design is a multi-faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior environment. These solutions are functional, enhance the quality of life and culture of the occupants and are aesthetically attractive. Designs are created in response to and coordinated with the building shell and acknowledge the physical location and social context of the project. Designs must adhere to code and regulatory requirements, and encourage the principles of environmental sustainability (National Council for Interior Design Qualification, 2012).

In addition, designers who come from the International Interior Design Association (IIDA) and other professional organizations define interior design in their terms:

Jack Weber noted that, "Design is everywhere. It touches and affects everyone. Design is human-centered" (Weber, 2012). Suzan Globus believes that the best designers are especially sensitive to the emotional reactions to the spaces they design because they establish human being as the basis of their approach to design (Globus, 2010, P3). All the definitions of interior design explain that interior designers' job is to satisfy people's needs for quality life, using processes, and emotions.

### 3. Landscape design

Landscape design is another main aspect of space design. "Landscape design is the practice makes an idea of landscape manifest as a material project. By transforming the land and determining the distribution of activities in space and time, it functions as a symbolic intermediary between natural systems and the human who inhabit them" (Erlhoff, Marshall, 2008).

#### C. Method: Method and Process

The relationships of method and process are complex. Sometimes, design process is a part of design method. Sometimes, it is just design method itself. Process is used to explain their methods in some definition as Evidence-based Design's definition. Therefore, design method and design process rely on each other in the comprehensive program.

#### 1. Definitions of Design Method and Relevant Term

The first part of the quote is from relevant literature about design method and design process, such as design method, design process, design planning and product development. The design process is a complex word to define. According to the *Design Dictionary* (Erlhoff, M., & Marshall, T., 2008), by Michael Erlhoff and Tim Marshall, the definition of design process is:

"Regardless of whether the generation of form is considered from an evolutionary perspective or from that of the practice-oriented disciplines, richly nuanced definitions of the design process can be derived from the interaction between actors and their environments"

(Erlhoff, Marshall, 2008). "Design method is designers use a broad range of method in the course of their work, many of which are also employed by partitioned in other disciplines" (Erlhoff, Marshall, 2008). Other relevant word about design method is design planning which also found in the book *Design Dictionary*. "Design planning is most salient in the early stage of projects, when strategies and tactics are addressed in a formal manner/ it is not usual, however, for designers to adjust such structural frameworks throughout the course of a project in response to unforeseen developments" (Erlhoff, Marshall, 2008).

In conclusion, the definition of design method and relevant terms are both in time and space dimension. The method focuses more on lengthways thinking and process, planning, and development focus on a horizontal development. Moreover, some design method's definition itself is a process.

## 2. Popular Space Design Method

Interior designers and architects use several design methods in their work. For example, Evidence-Based Design (EBD), Integrated Design Process (IDP), Archer's model of the stage of a design process, Front- End Concept Design Development Process, User-centered design and so on.

First, Evidence-Based Design took place on the health care environment design, school design, workspace environment design, and other public space because the methodology is developed from the evidence-based medicine system. Evidence-Based Design process is depended upon clients' expectation and the results from research. Evidence-based Design (EBD)

is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project (Hamilton, Watkins, 2009). In the book *Evidence-Based Design for Multiple Building Type*, the author offered a list that divided the process of evidence-based design in nine steps:

Step1. Establish the client's project goals

Step2. List the practitioner's project goals

Step3. Identify the one to three key design issues

Step4. Convert key design issues into research questions

Step5. Collect information and gather evidence that relate to the research questions

Step6. Critically interpret the evidence

Step7. Develop concepts to achieve desired design outcomes

Step8. Hypothesize predicted outcomes linked to the evidence-based concept

Step9. Select measure suited to the questions posed by the hypotheses (Hamilton, Watkins, 2009).

The second method is Integrated Design Process (IDP, Figure 3), which originally from the C-2000 process. The Integrated Design Process (IDP) has been developed on the basis of experience gained from a small Canadian demonstration program for high-performance buildings, the C2000 program (Larsson, 2004). The Integrated Design Process focuses on the relationship of relative design elements, and solves the design problem in an entire system.

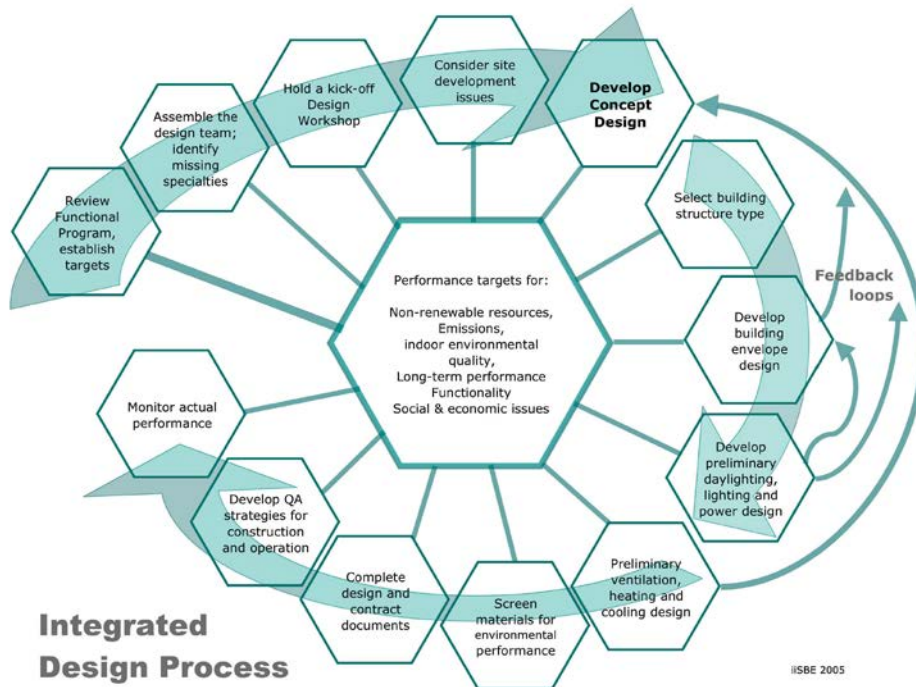


Figure 3, Integrated Design Process (Larsson, 2004).

The User-centered design is the third as well as a very popular design method not only for space design, but also for all the design fields. "User Centered Design (UCD) is a design methodology and process that focuses on the needs of end users, Limitations of end users, Preferences of end users, Business objectives. No matter what objectives you have for your site, it must carefully balance the needs of users and the needs of your organization" (Usability.gov, 2013).

The User-centered design method includes four parts. First, Planning the project includes develop a plan, project team, kick-off meeting, statement of work, hiring usability specialist. Second, analyze current site include evaluate current site, learn users, task analysis, personas, scenarios, measurable usability goals. Third, design new site is using card sorting to collect

information, and build prototypes. Fourth, Test the site is evaluation test and retest (Usability.gov, 2013).

Front-end concept design development process, the fourth method, is a formal design method for product development. The process of the design method is shown in Figure 4.

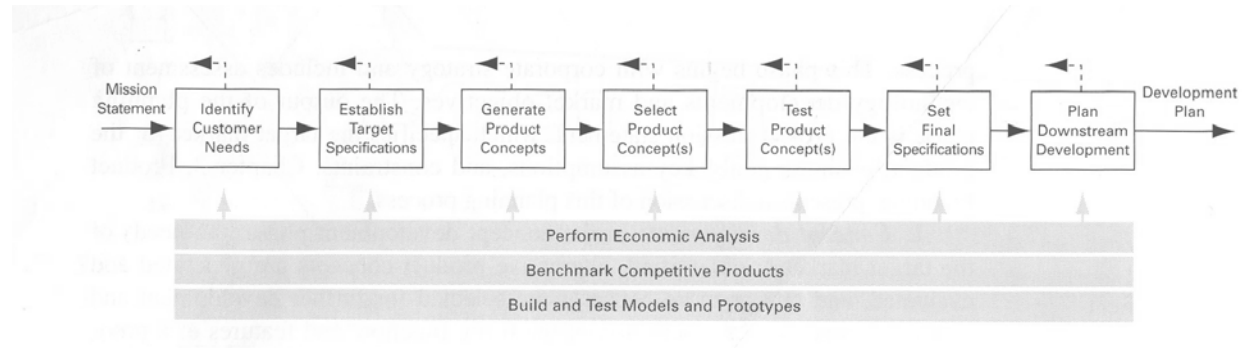
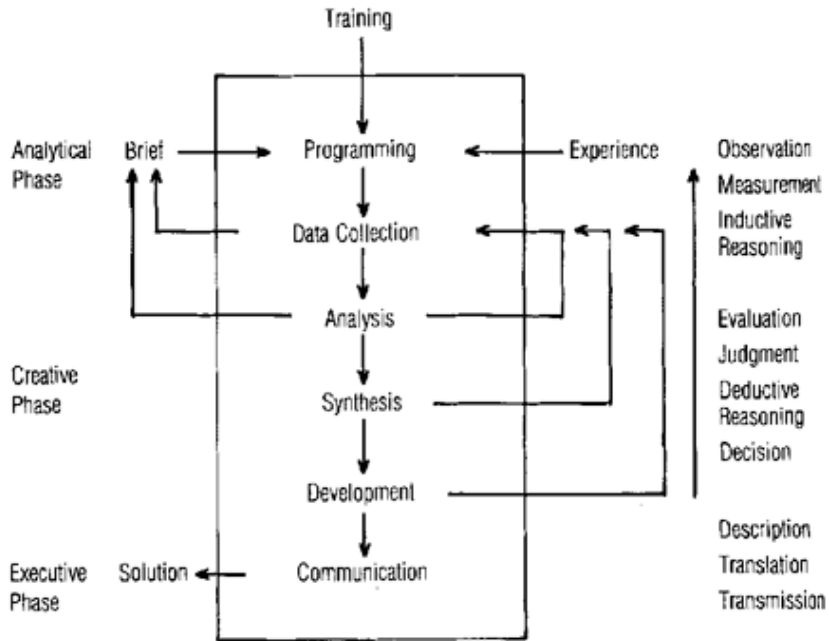


Figure 4, Front-End Concept Development Process (Ulrich, K. T., & Eppinger, S. D.,2000)

Archer's model illustrates the stages of a design process (Figure 5, Rowe, P, 1987). It is a simplified form made by Bruce Archer who was an industrial designer from the Royal College of Art in London. The model is a sequence that shows the operational process in a model. General form, irre-spective of particular circumstances, feedback loops, relationship between activities, and more evidence work in this model, and three interrelated realms for the process are external representation, process of activities, and the problem solver (Rowe, P., 1987).



Archer's model of the stages of a design process.

Figure 5, Archer's model of the stage of a design process (Rowe, P., 1987)

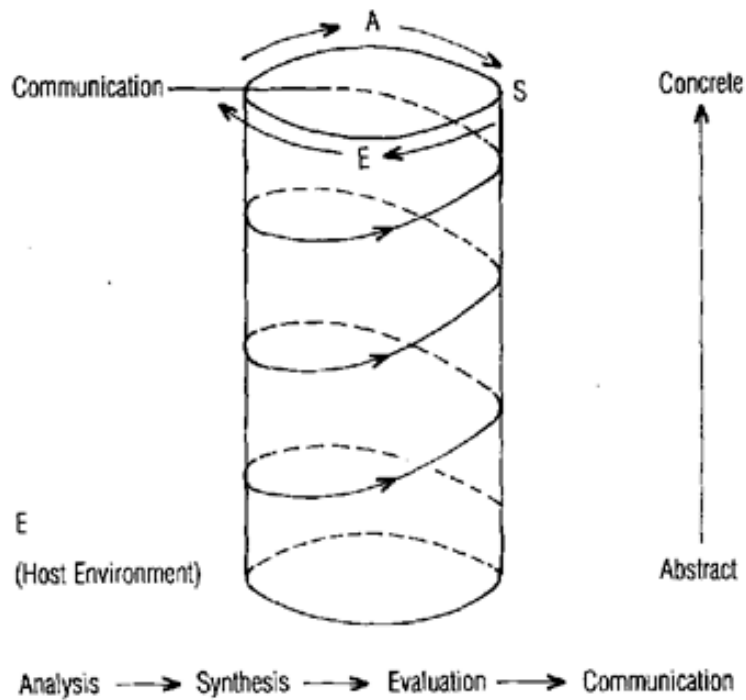


Figure 6, Iconic model of a design process (Rowe, P., 1987)

Asimov distinguishes two directions in the design process that are vertical direction involves a sequential phasing of activities and a horizontal direction in the decision-making cycle. Put four main design elements, analysis, synthesis, evaluation and communication, in two directions will build a form called "iconic model" by Mesarovic" (Rowe, P., 1987, Figure 6).

The four typology of design models (Blessing, 1994) shows four design methods by Blessing in 1994. These models are corresponding to the popular space design methods. For example, Evidence-Based design is a design method as the part A in Figure 1. Iconic model of a design process (Figure 3) is the part C in Figure 1.

Among all spatial design methods, the generic design method and process include in the Iconic model of a design process.

#### Step 1: Data collection and Analysis

Code, natural environment, weather, other common information. etc (in general ). A special needs analysis of significant users' goals, budget, functions, personality, etc (antiviral). In addition, the analysis always happens in the data collection process.

#### Step 2: synthesis

The synthesis stage is almost is build the Archer's model of the stage.

#### Step 3: Evaluation

Judgment and evaluation analysis are from re-analysis and re-synthesis.

#### Step 4: communication



Design is not project for designers themselves because designers need to sale their work and provide best service to their clients.

In fact, these four steps classified a general design elements classification. Thousand elements and details can be classified to these five main steps. For example, lighting collection, the simple topic relates to personal needs, design type, budget, design finalization, and so on. If the project wants sustainable, more information should be considered. The step four is the most important part because design work is a balance process and finds the best choice for a project; even designers use the most simple structure and materials.

In conclusion, different design methods show different visions and design logics for design projects. Sometimes, these design methods show irreconcilable differences, despite all the design methods want to build a better space for the client. By the way, some architects and designers have a particular personal style as Frank Gehry who use a similar style in several buildings, and using particular style become a unique identity in their design process.

### **III. The subjects of design users and goals for space deign are multifarious and has been changed**

The subjects of space design users and goals for space deign are multifarious, and human being is one of them. In philosophical vision, human is a part, but not the foundation of the world. Then, the subjects of space design users, goals and materials for space deign have been changed, and they can be distinguish by physical and psychology.

A. The subjects of space design users and goals for space design are multifarious

The subjects of space design are multifarious and human being is one of them. In philosophical vision, human is a part, but not the foundation of the world. Sustainable design can be the starting point where humans begin to coordinate the relationship between human and nature environment. For example, plants are the primary user for greenhouses while human is actually operating them. The temperature in the greenhouses should depend on the need of plants, not human. Human can grow plants, but they cannot create plants. On the aspect of space using, plants and human should keep equal relationship with each other. This is an example that explains the work of space designers is for everything that takes up space. Sustainable design (green design) is one of the comprehensive visions that people would like to use in order to protect the environment on the Earth.

Even a space is built for human use. However, the clients' goals and needs are different. Designers and architects classify their clients and goals by using several different characteristics. For example, architects and interior designers will consider more Evidence-Based design methods for a client who needs the healthcare space. This is a problem, but also an interesting challenge for architects and designers. The goal of space design may be used to achieve efficiency, performance, health, comfort, and so forth. The goal for space design may also be a combination of both efficiency and performance. A space design goal may even have more than three characteristics. Generations, culture, educational background, gender, budget classifies, habit, and other information can be used to help architects and designers to understand their

clients and clients' goals. For a designer or an architect, all the goals and information need to be considered again and again in both individual space design and commercial space design.

Personality and design goals are multifarious in human living space design field. For designers or architects, they never know their next clients and the goals of those clients.

In order to understand and compartmentalize the needs and goals of the clients, we can utilize the Maslow's hierarchy of needs. The Maslow's hierarchy of needs (Figure 7) is the map that can be used by designers and architects to analyze the diversity of design goals. In the article named *A theory of human motivation*, Maslow classified the five levels of human needs. The physiological needs, also called physiology drive, are the very first point that needs to be satisfied in motivation theory. The safety needs then serve as the second most exclusive generalizing behavior which includes all the basic capacities of the organism, and we as human, like all other organisms have safety-seeking mechanism. The safety needs include personal safety, health and well-being safety, safety, employment and so on. The need for love depends on physiology and safety needs, upon satisfying the foundations of the first two needs, the whole cycle described earlier will repeat itself with this new center. The esteem needs states that all people have needs or desire for a stable, firmly based status. They need to high evaluation for self-respect, self-esteem, and for the respect of others. The self-actualization is where all man wants to be. (Maslow, A. H., 1943). The Maslow's hierarchy of needs was created to analysis human needs in psychology in 1943, but it still works for today's society.

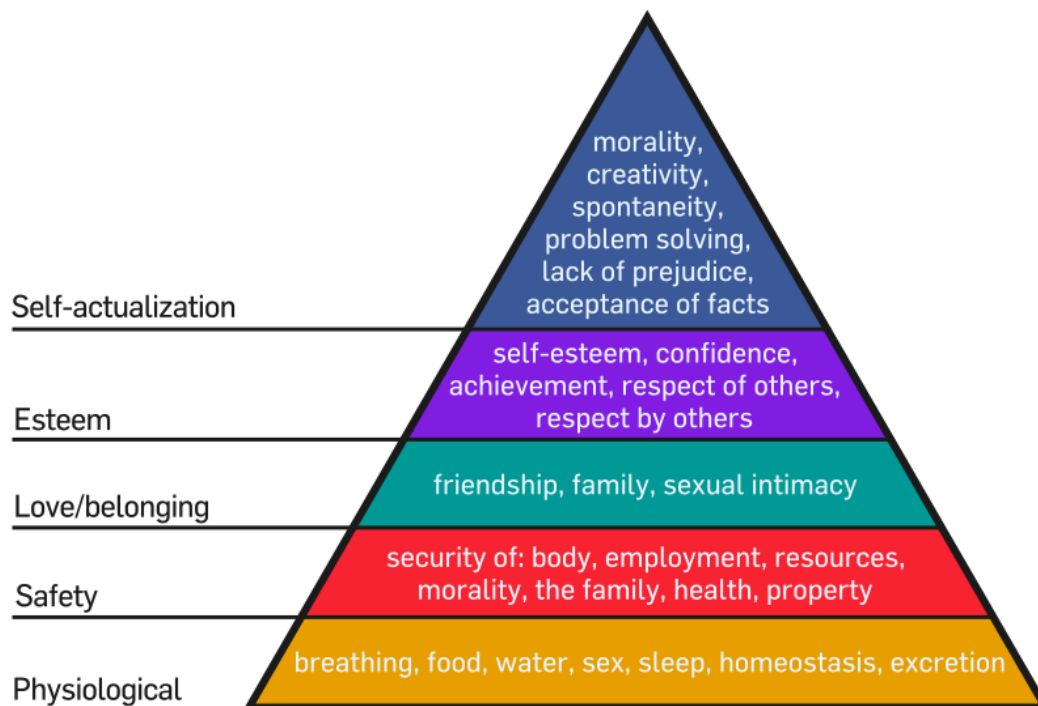


Figure 7, Maslow's hierarchy of needs (Simons, J. A., Irwin, D. B., & Drinnin, 1987)

Space design projects provide various spaces for all the human needs. Living space, working space, health care space, and some other public space all work for human being's physical needs or psychological needs. In the modern society, everyone uses Individual space, commercial spaces, and public spaces. Comparing Maslow's hierarchy of needs and space types, all the spatial design types have one or more than one their own corresponding meaning in physical and psychological needs. For example, a restaurant can serve as a space to provide foods at a physical level; on top of that, it can be used to build friendship on a psychological level to satisfy the love and belonging needs. The human living space environment, workspace environment, and entire public space have a tight relationship with human needs.

Space designers always emphasize on the highest level of human needs, and users' satisfaction, because their purpose is to build a place they love. People need positive emotions and influence from interior context for their daily lives and entire lives, and interior design works also follow this purpose. Dual characteristic is a basic theory for an interior design. Even though positive effect and negative effect can be switched for different clients, people have a similar reflection towards interior design. There will be some happiness and well-being positive senses to be appeared by using the right elements for a requisition to build an environment for particular clients. Interior design is a process that designers avoid inconvenience and blow up specific interests and needs for their clients. Then, there will be more positive emotion growth, which in turn will build a positive emotion for people.

Five survey questions can estimate if a person is happy or not. The five question survey named WHO-5 is designed by World Health Organization (WHO) during the later period of last century. The well-being Index was then developed for the purpose of measuring positive mental health. Subject psychology well-being or health-related quality of life is often considered to be a rather individualistic, personal or idiographic issue, implying that a cross-cultural definition is very difficult to be obtained. The WHO-5 includes the following five items:

- Feeling cheerful and in good spirits,
- Feeling calm and relaxed,
- Feeling active and vigorous,

- Feeling fresh and rested when waking up,
- Feeling interested in day-to-day activities (Bech, Olsen & Kjoller, 2012).

In space design program, all the five feelings should be reflecting for interior context, even though some feelings in WHO-5 also happen outside. Most people may image that fresh feeling and rested while waking up in their bedroom. Wilson states happy people are “young, healthy, well-educated, well-paid, extroverted, optimistic, worry-free, religious, married person with high self-esteem job morale, modest aspiration, of either sex and of a wide range of intelligence” (Wilson, 1967). These words are not conclusive to define happy people, but it is helpful to for us to imagine a person who is always feeling cheerful, calm, active, fresh, and interested. Happiness is a material to build people's whole life from the aspects of time and meaning.

B. The subjects of space design users and goals for space deign have been changed.

In the last century, the economic development, cultural development, technology development, and world revolution, and all the development and change bring various changes to space design goals and needs. These developments and changes will continue and give designers more challenges in the future. A basic example of the changing is that the average size of American home was doubled from 1950s to 1990s, and it is still growing. The U.S. Department of Commerce reports the *Median and Average Square Feet of Floor Area in New Single-Family Houses* from 1973 to 2010 showed the change (Figure 8). In addition, the home size growing is

not solely an isolated phenomenon, and also is affected by the changes of the relative design phenomenon.

**Median and Average Square Feet of Floor Area in New Single-Family Houses Completed by Location<sup>1</sup>**  
(Medians and averages computed from unrounded figures)

Year	Median square feet							Average square feet						
	United States	Inside MSAs	Outside MSAs	Region				United States	Inside MSAs	Outside MSAs	Region			
				North-east	Midwest	South	West				North-east	Midwest	South	West
1973	1,525	1,625	1,380	1,450	1,445	1,555	1,575	1,660	1,760	1,490	1,595	1,615	1,670	1,715
1974	1,560	1,665	1,405	1,465	1,490	1,640	1,540	1,695	1,785	1,545	1,600	1,660	1,760	1,660
1975	1,535	1,630	1,365	1,405	1,460	1,605	1,510	1,645	1,735	1,490	1,575	1,580	1,705	1,635
1976	1,590	1,675	1,425	1,505	1,495	1,660	1,565	1,700	1,775	1,560	1,630	1,655	1,755	1,685
1977	1,610	1,705	1,440	1,540	1,540	1,660	1,615	1,720	1,795	1,565	1,650	1,650	1,770	1,730
1978	1,655	1,735	1,490	1,640	1,615	1,685	1,630	1,755	1,830	1,610	1,730	1,730	1,785	1,740
1979	1,645	1,735	1,485	1,690	1,605	1,675	1,625	1,760	1,845	1,605	1,795	1,720	1,795	1,730
1980	1,595	1,670	1,450	1,660	1,520	1,615	1,570	1,740	1,825	1,575	1,770	1,685	1,750	1,735
1981	1,550	1,650	1,415	1,655	1,480	1,540	1,580	1,720	1,820	1,535	1,805	1,670	1,715	1,735
1982	1,520	1,600	1,355	1,605	1,405	1,500	1,595	1,710	1,795	1,545	1,755	1,655	1,700	1,740
1983	1,565	1,610	1,445	1,650	1,515	1,565	1,545	1,725	1,785	1,570	1,795	1,735	1,720	1,695
1984	1,605	1,645	1,495	1,665	1,600	1,590	1,610	1,780	1,840	1,600	1,860	1,800	1,750	1,785
1985	1,605	1,655	1,445	1,655	1,625	1,590	1,595	1,785	1,830	1,610	1,830	1,820	1,765	1,770
1986	1,660	1,700	1,470	1,695	1,685	1,655	1,635	1,825	1,865	1,640	1,850	1,855	1,825	1,800
1987	1,755	1,800	1,565	1,840	1,740	1,755	1,730	1,905	1,950	1,700	1,955	1,890	1,915	1,870
1988	1,810	1,880	1,570	1,810	1,840	1,790	1,845	1,995	2,055	1,750	2,005	2,015	1,985	1,995
1989	1,850	1,920	1,570	1,870	1,800	1,815	1,910	2,035	2,105	1,750	2,075	1,970	2,030	2,065
1990	1,905	1,985	1,630	1,955	1,850	1,855	1,985	2,080	2,155	1,800	2,105	2,005	2,055	2,160
1991	1,890	1,970	1,635	1,950	1,800	1,870	1,980	2,075	2,155	1,815	2,105	1,990	2,065	2,155
1992	1,920	1,990	1,700	2,000	1,870	1,945	1,890	2,095	2,160	1,870	2,115	2,020	2,130	2,090
1993	1,945	2,000	1,700	2,050	1,855	2,000	1,845	2,095	2,160	1,860	2,160	2,025	2,150	2,050
1994	1,940	1,995	1,700	2,035	1,850	2,000	1,835	2,100	2,160	1,865	2,195	2,025	2,165	2,025
1995	1,920	1,975	1,720	2,095	1,850	1,945	1,835	2,095	2,150	1,870	2,240	2,020	2,125	2,045
1996	1,950	2,000	1,735	2,100	1,900	1,995	1,890	2,120	2,170	1,915	2,280	2,025	2,160	2,070
1997	1,975	2,015	1,765	2,130	1,900	2,000	1,930	2,150	2,200	1,955	2,265	2,065	2,175	2,135
1998	2,000	2,050	1,750	2,100	1,945	2,000	1,985	2,190	2,250	1,930	2,270	2,125	2,200	2,200
1999	2,028	2,089	1,811	2,175	1,937	2,044	2,001	2,223	2,274	1,991	2,298	2,135	2,244	2,234
2000	2,057	2,121	1,824	2,266	1,971	2,075	2,014	2,266	2,321	2,024	2,435	2,170	2,287	2,244
2001	2,103	2,152	1,905	2,305	1,965	2,128	2,080	2,324	2,361	2,162	2,466	2,209	2,351	2,317
2002	2,114	2,171	1,884	2,330	1,979	2,120	2,127	2,320	2,379	2,068	2,516	2,209	2,317	2,350
2003	2,137	2,177	1,941	2,288	1,998	2,142	2,166	2,330	2,382	2,113	2,443	2,198	2,335	2,387
2004	2,140	2,207	1,933	2,361	1,993	2,164	2,149	2,349	2,402	2,122	2,543	2,222	2,368	2,352
2005	2,227	2,273	1,952	2,339	2,054	2,259	2,236	2,434	2,479	2,137	2,556	2,310	2,463	2,434
2006	2,248	2,305	1,909	2,395	2,035	2,286	2,275	2,469	2,519	2,120	2,612	2,290	2,499	2,488
2007	2,277	2,319	1,956	2,281	2,064	2,325	2,286	2,521	2,581	2,133	2,550	2,328	2,573	2,524
2008	2,215	2,270	1,963	2,312	2,019	2,266	2,216	2,519	2,582	2,203	2,651	2,331	2,564	2,508
2009	2,135	2,185	1,909	2,211	1,931	2,198	2,140	2,438	2,490	2,156	2,594	2,216	2,488	2,434
2010	2,169	2,203	1,877	2,336	2,001	2,184	2,143	2,392	2,443	2,091	2,613	2,265	2,393	2,386
RSE	2	2	4	6	3	4	3	2	2	4	6	2	3	4

A Represents an RSE that is greater than or equal to 100 or could not be computed.

NA Not available. RSE Relative Standard Error.

S Withheld because estimate did not meet publication standards on the basis of response rate, associated standard error, or a consistency review.

<sup>1</sup>Includes houses built for rent (not shown separately).

Figure 8, Median and Average Square Feet by Location (U.S. Department of Commerce, 2013)

The result of these changes lead to more diversity. Diversity and flexible characteristics have been shown in generations of clients. The new generation ranges from the year of 1981 to 2000, and the generation is called by several names such as millennial, Generation Y, Echo boomers, Generation next, Echo boomers, Chief friendship officers, 24/7s. Their ages are from 11 to 33, and they will become the main part of workspace environment users and have their own space. The Generation Y has their individual characteristic and habit. First of all, Generation Y grew up with technology development, such as smartphone, laptops, and other electronic devices to carry out their life. They also uses Facebook, twitter, and other messaging rather than face-to-face communication to socialize. Secondly, Generation Y prefers flexible and well balanced work/life schedules, even though some Generation Y who works in the field of law sets work in the top priority. Third, Generation Y is confident, ambitious and achievement-oriented in their work, and they like new challenges and questioning authority. Fourth, Generation Y values teamwork, and seeks the input and the affirmation; they have excellent practice in team sport since childhood (Gaylor, D, 2002). Figure 9 explained the difference between the modern generation and their parents. These different interpretations come from historical perspective, and also aim at the causes of those differences. Different designers also need to think about the nature of the problem as well.



### Generational Differences Chart

	<b>Traditionalists</b>	<b>Baby Boomers</b>	<b>Generation X</b>	<b>Millennials</b>
<b>Birth Years</b>	1900-1945	1946-1964	1965-1980	(1977-1994) 1981-2000
<b>Current Age</b>	63-86	44-62	28-43	8-27
<b>Famous People</b>	Bob Dole, Elizabeth Taylor	Bill Clinton, Meryl Streep	Barak Obama, Jennifer Lopez	Ashton Kutcher, Serena Williams
<b>#</b>		80 Million	51 Million	75 Million
<b>Other Names</b>	Veterans, Silent, Moral Authority, Radio Babies, The Forgotten Generation	"Me" Generation, Moral Authority	Gen X, Xers, The Doer, Post Boomers, 13 <sup>th</sup> Generation	Generation Y, Gen Y, Generation Next, Echo Boomers, Chief Friendship Officers, 24/7's
<b>Influencers</b>	<p>WWII, Korean War, Great Depression, New Deal, Rise on Corporations, Space Age,</p> <p>Raised by parents that just survived the Great Depression.</p> <p>Experienced hard times while growing up which were followed by times of prosperity.</p>	<p>Civil Rights, Vietnam War, Sexual Revolution, Cold War/Russia, Space Travel</p> <p>Highest divorce rate and 2<sup>nd</sup> marriages in history.</p> <p>Post War Babies who grew up to be radicals of the 70's and yuppies of the 80's.</p> <p>"The American Dream" was promised to them as children and they pursue it. As a result they are seen as being greedy, materialistic and ambitious.</p>	<p>Watergate, Energy Crisis, Dual Income families and single parents, First Generation of Latchkey Kids, Y2K, Energy Crisis, Activism, Corp. Downsizing, End of Cold War, Mom's work, Increase divorce rate.</p> <p>Their perceptions are shaped by growing up having to take care of themselves early and watching their politicians lie and their parents get laid off.</p> <p>Came of age when USA was losing its status as the most powerful and prosperous nation in the world.</p> <p>The first generation that will NOT do as well financially as their parents did.</p>	<p>Digital Media, child focused world, school shootings, terrorist attacks, AIDS, 9/11 terrorist attacks.</p> <p>Typically grew up as children of divorce &amp; to turn around all the "wrong" they see in the world today.</p> <p>They grew up more sheltered than any other generation as parents strived to protect them from the evils of the world.</p> <p>Came of age in a period of economic expansion.</p> <p>Kept busy as kids</p> <p>First generation of children with schedules.</p>

Figure 9, Generational Difference Chart (Gaylor, D, 2002)

Comparing with Generation X, the space design goals is different from generation Y.

The space design advances to better suit for the younger generation since the previous change from Baby Boomers to Generation X. For the last space design needs and goals changing question, it was change to the computer era. In last 10 years, the portable technology change a lot for Generation X and Generation Y. The technology development is also support designers to serve young people.

In conclusion, users and their goals for space design are multifarious and also changed. The space design users are multifarious and they are changing to Generation Y. Then, Generation Y's goals for space design are still changing more than their parents' goals.

### C. Distinguish physical and psychology goals for Space Design

In space design field, the space design also can be distinguished to physical, psychology, and several design programs; and design methods have used to improve the space design qualities.

Space design work for human physical needs is a truth for all users; even single spaces have other heterogenic functions. Universal Design is a specialized field in space design. Universal design was created by the architect named Ronald L. Macein 1985. Universal design refers to broad-spectrum ideas which were meant to produce buildings, products and environments that are inherently accessible to both people with disabilities and people without disabilities. Americans with Disabilities Act of 1990 (ADA) and Americans with Disabilities Act of 2008 (ADAAA) set standards for construction of accessible public space design.

On the other hand, space designers always work for clients' satisfactions because their purpose is to build a place clients like. For example, the design needs to be functional for the clients and the style needs to meet the client's taste. Over the history of interior design, interior designers focus on client's needs and their social circle. A sense of happiness on a psychological level is reached, when the clients are satisfied with the design. Happiness and well-being that are

caused by people's satisfaction is a significant part in the positive psychology field. Positive psychology also is new views interior designers can take a new look for their work. The definition of positive psychology is that, "the field of positive psychology at the subjective level is about positive subjective experience: well-being and satisfaction (past); flow, joy, the sensual pleasure, and happiness (present), and constructive cognitions about the future—optimism, hope, and Faith" (Snyder & Lopez, 2002). Martin Seligman, positive psychologist and president of the American Psychological Association, defines a pleasant life as a life filled with positive feelings and activities. He believes that a psychology of positive human functioning will arise, which achieves a scientific understanding and effective interventions to build thriving individuals, families, and communities (Seligman, 2000). In four topics of positive psychology, positive experiences, enduring psychological traits, positive relationships and positive institutions (Peterson, 2009), interior design can provide positive usage experiences and fit space for people to build their relationship with others both in individual level and group level. Interior design work can affect people positively. Evidence-based Design (EBD), work for health care environment design, school design, workspace environment design, and other public space for psychology because the methodology is developed from the evidence-based information that include psychology research.

In Conclusion, space design users and their needs are multifarious and have been changing. First, the subjects of design users and goals for space design are multifarious because human needs. Secondly, the subjects of design users and goals for space design have been



After researching on common space design methods as well as combining with diverse spatial design goals and generation changes, designers might need a new space design method to better fit the new characteristics in space design. Since Evidence-Based Design becomes more recognized and popular, a creation of new design method is not impossible for young designers. Computer-Aided Design has developed rapidly in last half century because the development of technology and more efficient marketing plan. For instance, Autodesk Company has developed designing software that allows for two-dimensional and three-dimensional designs. In addition, it also designed and marketed other computer-aided programs in spatial design. Compare to the original computer-aided software, those new editions are more intuitive, concise, efficient and highly integrated. Revit Architecture is a modern software program that demonstrates the intuitive and integrated features. Compare to the computer-aided design, Archer's design model always implement as the basic knowledge. From a logical viewpoint, Archer's design model is the groundwork for evidence-base design. In addition, many other design methods are based on the Archer's design model, such as universal design.

With the rapid development of the technology, people's habits and life qualities are changed as well. Young generation like to explore new design techniques and embrace the enjoyment and conveniences from within. Young generations rely on creative designs even more than their parents do. They are less tolerant towards low speed information transmission systems. In fact, it is hard for them to adopt the traditional way of mailing service. A new research reveals that many professional internet users cannot bear 1/8 second of network delay. Young

generations, especially digital natives, are rely on their mobile telecommunication, such as smart phone or digital tablet. Facebook and Twitter are the main social communication tools for them to connect to other people such as friends, family members, colleagues or even someone they have never met before. Face-to-face communication becomes less and less in young generations and all these changes happened in merely the past 20 years. As a designer for spatial design, these issues need to be considered.

There is disparities exist between design method and changes in younger generations in today's society. Here is a question to be considered: How should design method transform to better serve the younger generation during the process of spatial design? The answer shall be illustrated in the next few sections.

#### A. Design methods can be combined to build a new design process and thinking map

On top of all the methods previously discussed, designers are using thousands of other methods as well. Designers can use a single method or combination of different methods. Each methods introduced in the previous sections have their own features. Although, most of them can be derived through a simple logical thinking, some of the methods are derived from scientific researches where there is clear defined timeline of the design progress. More methods are used in other design fields. For example, designers to consider clients, laws, neighborhood environment and so forth can use the Stakeholder Map. Affinity Diagramming, Automated Remote Research, Brainstorm Graphic Organizers, Concept Mapping, Kano Analysis, Cognitive mapping,

Stakeholder Maps are different design method that will be introduced in the next several paragraphs, although they might only be the methods for detailed processing.

Affinity Diagramming: a process used to externalize and meaning fully cluster observations and insights from research, keeping design teams grounded in data as they design”( Martin, B., & Hanington, B. M. 2012). The figure 11, Affinity Diagram from FE all-Hands Brainstorm, show the design method very clear.

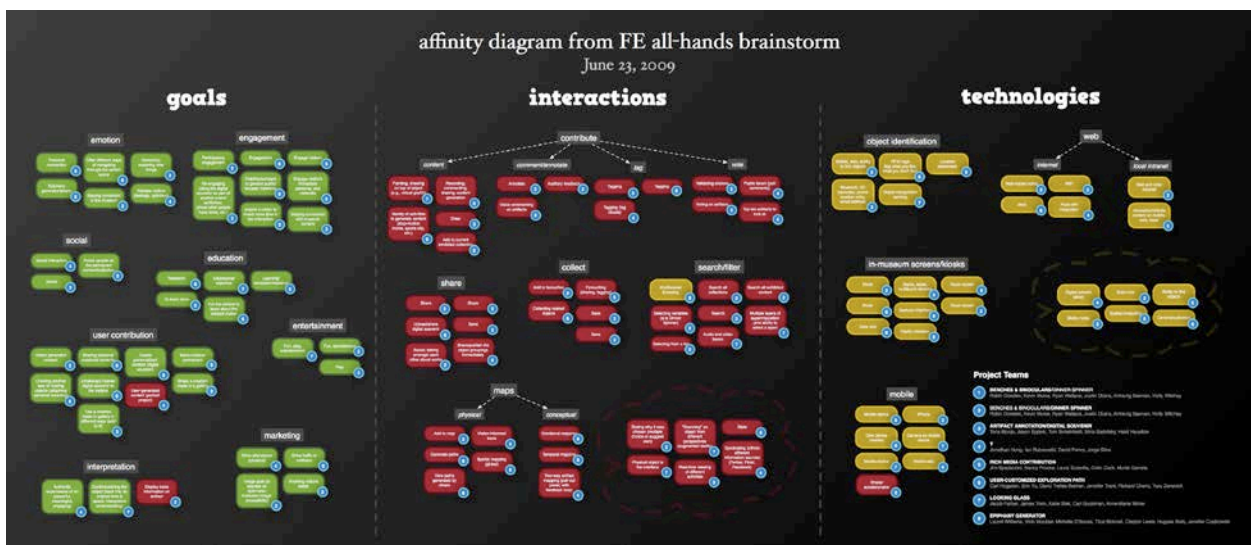


Figure 11, Affinity Diagram from FE all-Hands Brainstorm (Yoon, j, 2009)

Automated Remote Research (Figure 12): a method that can reveal statistically relevant data about what people are doing on your website, to help identify the usability enhancements with the biggest impact” (Martin, B., & Hanington, B. M. 2012).

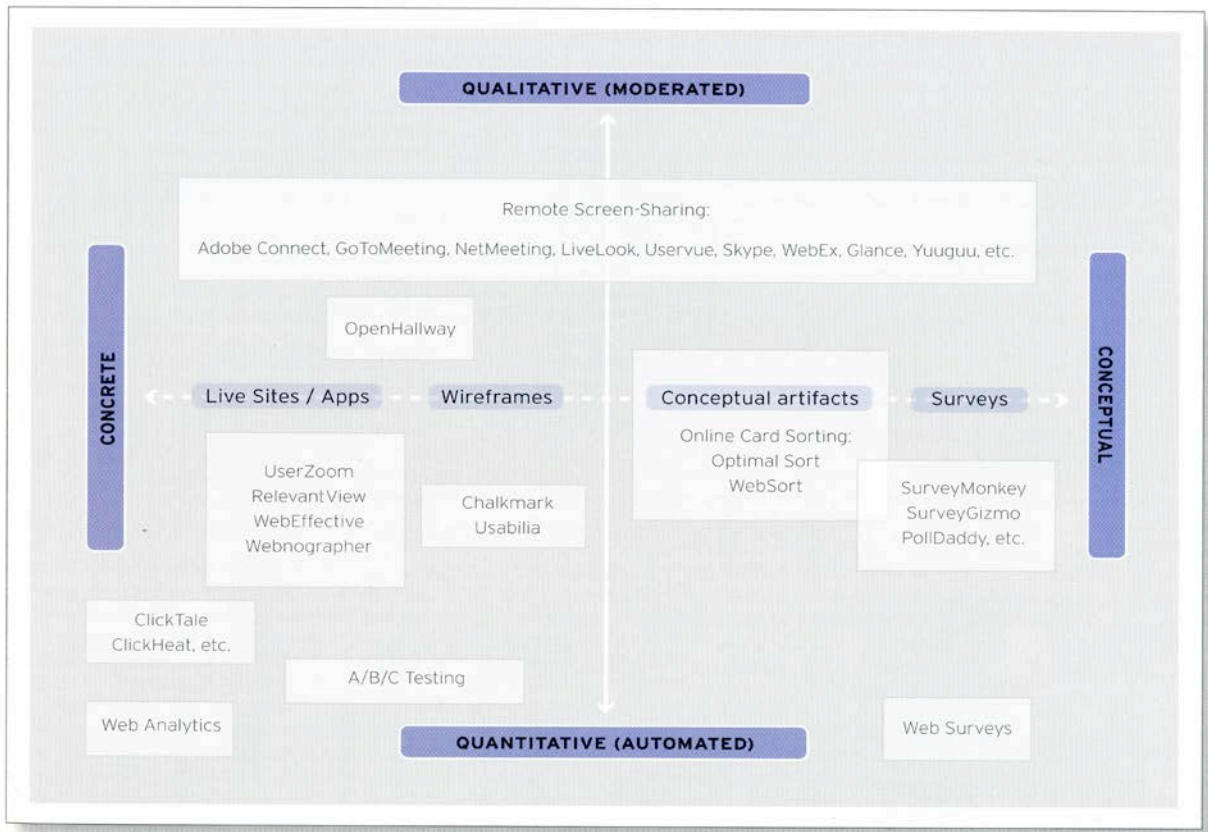


Figure 12, Automated Remote Research Form (Martin, B., & Hanington, B. M. 2012)

Brainstorm Graphic Organizers: beyond creating lists of new ideas and concepts, brainstorm graphic organizers help in the creation of new knowledge by visually structuring a deep dive into a problem space.” (Martin, B., & Hanington, B. M. 2012). The Figure 13 Example of Brainstorm Graphic Organizers shows the relationship of idea development.





Figure 13, Example of Brainstorm Graphic Organizers (Martin, B., & Hanington, B. M. 2012)

Concept Mapping (Figure 14) is a visual framework that allows designers to absorb new concepts into an existing understanding of a domain so that new meaning can be made” (Novak, J & Canas, A, 2010)

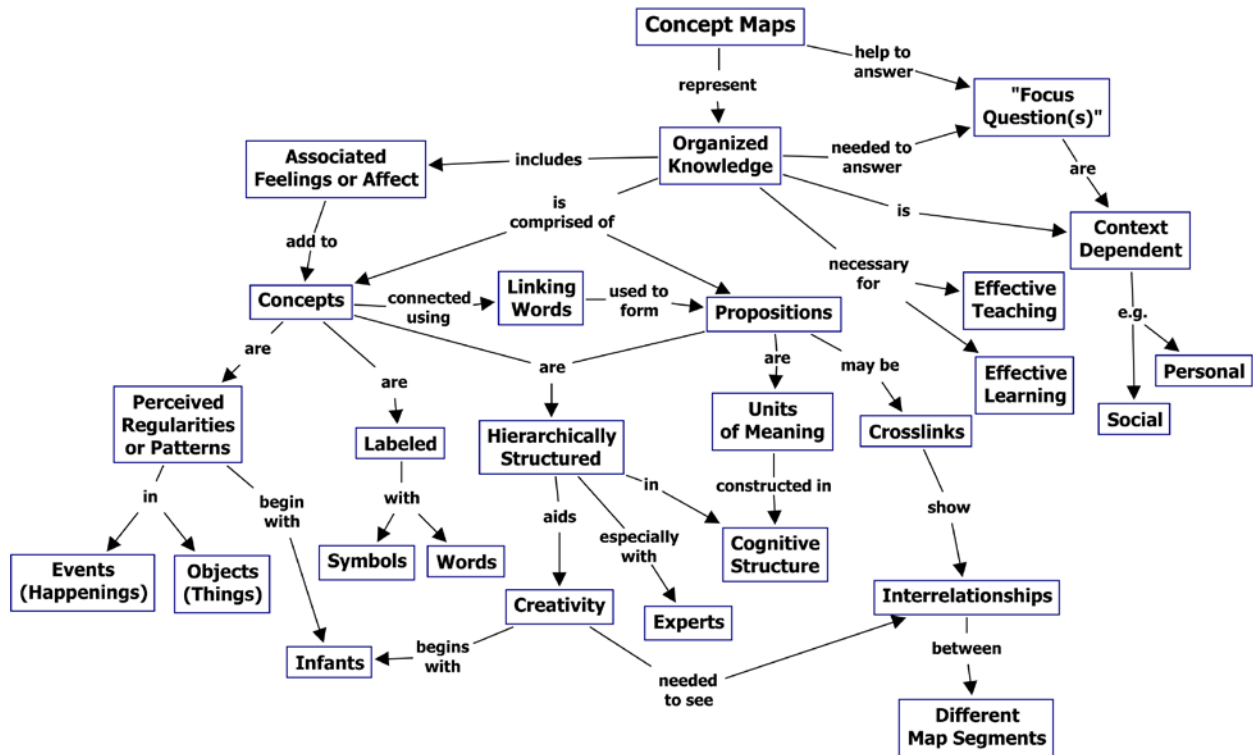


Figure 14, Concept mapping (Novak, J & Canas, A, 2010)

Kano Analysis (Figure 15) is based on the philosophy that the constant addition of new features—the “more is better” approach—is an ineffective strategy when trying to improve customer satisfaction (Martin, B., & Hanington, B. M. 2012).

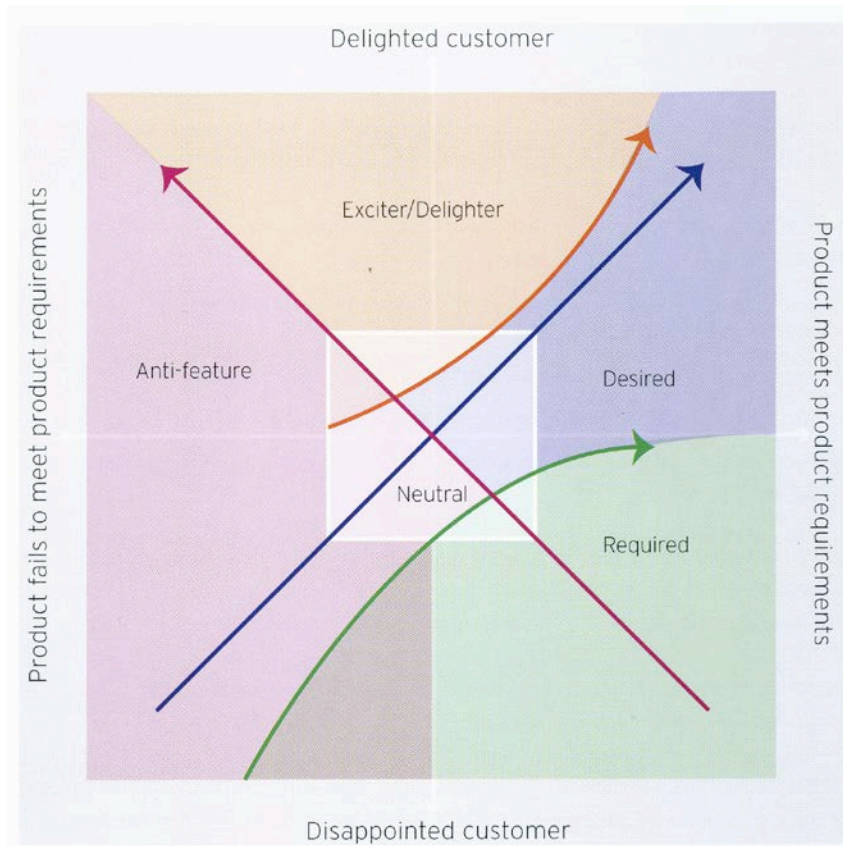


Figure 15, Kano analysis (Martin, B., & Hanington, B. M. 2012)

Cognitive mapping (Figure 16) states that “an information technique that can be used as a decision-and –sense- making tool. Its purpose is to reveal how people think about a problem space, and visualize how they process and make sense of their experience” (Martin, B., & Hanington, B. M. 2012).

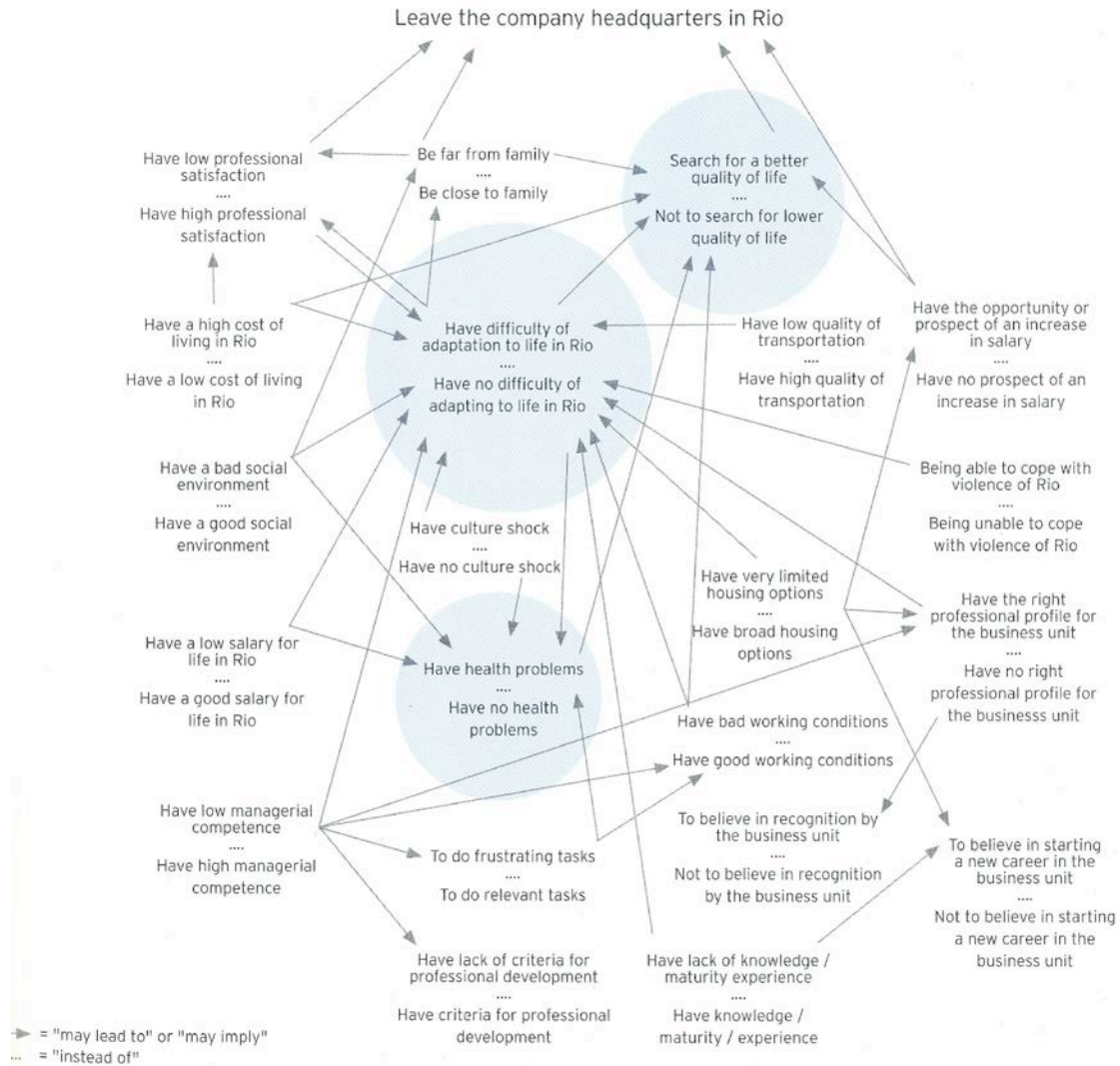


Figure 16, Cognitive mapping (Martin, B., & Hanington, B. M. 2012)

Stakeholder Maps (Figure 17): “Stakeholder maps help to visually consolidate and communicate the key constituents of a design project, setting the stage for user-centered research and design development.” (Martin, B., & Hanington, B. M. 2012). This design method not only works for space design, but the relationship works for all designers and clients. As the Generation change, the relationship will need to be reconsidered for younger people and their communication style.

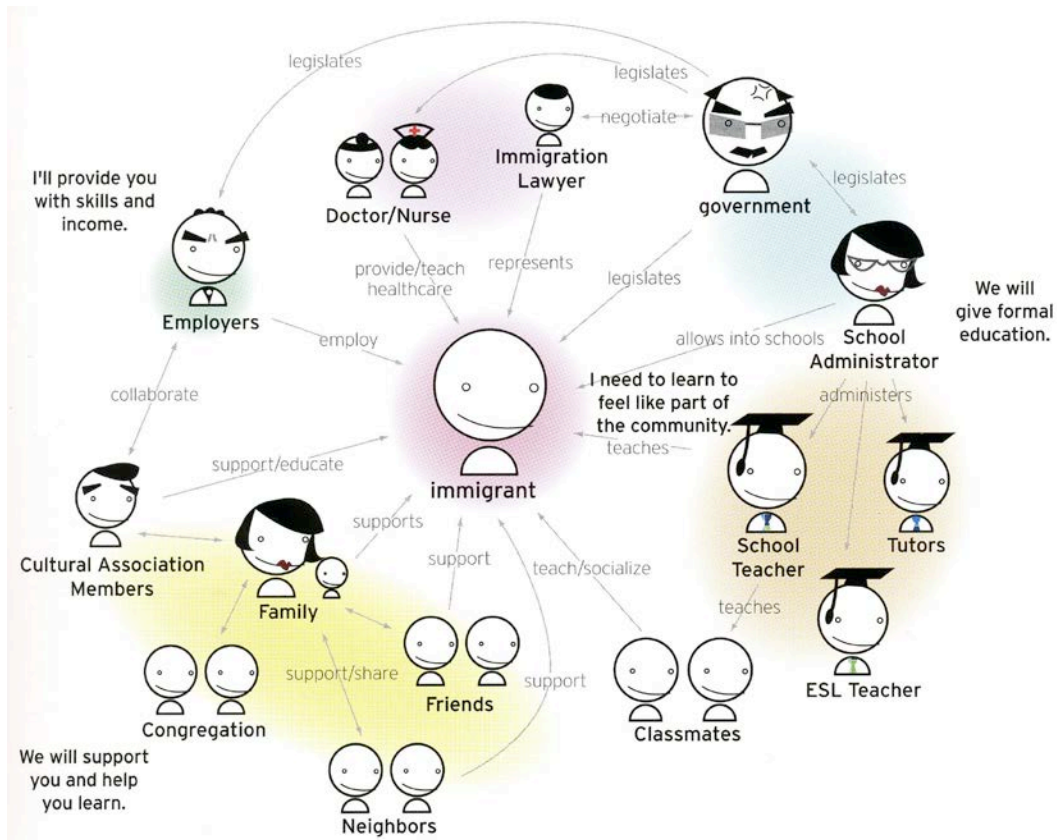


Figure 17. Stakeholder Maps (Martin, B., & Hanington, B. M. 2012)

All of the design methods above are very useful for a designer. For example, Stakeholder map is looked that it displays little client relationship to the spatial design (Stakeholder Map, Figure, 17). It can be used for the composition and arrangement of space to create a natural link into the specific space design if the design should be placed in rooms that it depends on this map in a large extent. However, the space design methods above merely include sectional space design contents. The whole space design contents contained far more than the sectional parts because the contents contained by the basic design methods have stayed on the level of Paper-pencil. In order to achieve functions, feelings and so forth, it is essential and

visible to use building materials during the period of space design. In other words, space design results are related to the tactile aspect, visual aspect, auditory aspect, or even to the sense of smelling. Specifically, people prefer to feel the size of the room, touch the sofa material, hear the sound of knocking between the heels and marble floor, and even the mixing smelling of various building materials and so on, while they are using a room. In the book, *Thinking in sound: The Cognitive Psychology of Human Audition* said that sound and auditory scene yields knowledge of environment, including spatial knowledge (McAdams. S. & Bigand. E. 1993). As a result, spatial design methods and thinking processes are not just like kind of the paper-pencil level thinking, and they needs more information about space elements.

#### B. Design Methods (Thinking Process) and Achievement

Design method and thinking process is assembling and thinking design elements in order to achieve final goals and needs. Just like the method from Archer (Archer's Model of the Stage of a Design Process), the process does not show any relationship in spatial design. It demonstrated the basic logic and method. If the Archer method and the evidence-based design work together, design method and thoughts will become more apparent than before. Archer design method is the logical structure and the process of evidence-based design is subject and content.

Dr. Mirek Piechowski used a method to mix Evidence-Based Design and Integrated Design (IDP). It discussed a hot topic in the design field, which is sustainable design. Through

the integrated and evidence based thinking that Integrated design strategies aim to combine passive design solutions with the building's services to create a bio-responsive building that provide optimal indoor environmental quality and high level of energy efficiency " (Piechowski, M., 2011). Except this, Dr. Mirek Piechowski think" successful reconciliation of environmental and commercial outcomes can only be achieved by careful consideration of key design, construction and operational variables. We argue that this can only be achieved by considered and comprehensive response to the design brief and external environmental conditions... Past experience also suggests that integrating input from key stakeholders and design and construction team early at the concept development stage also reduces the overall cost of the project"(Piechowski, M., 2011)..

There are many design methods and elements were used by designer in spatial design. The quantity of elements is enormous so that designers cannot manipulate all the elements were used by them. It is hard to give examples of all the elements that we used now. Designers can only use classification method to sort infinite design elements. As far as the construction of physical elements, they are planning, site, concrete, masonry, material, thermal, doors and windows, finishing, specialties, equipment, furnishings, construction, conveying system, mechanical, electrical, sports & game facilities, energy and environmental design, building types, etc. All those elements compare and analysis repeatedly in the process of design. This is why architects are hired. Besides those design elements, architects also need to think about how to communicate with their clients, understand what objective clients have and then stand at clients'

position to design. As prestige designers, they know how to market their ideas. The final product of design is a physical object, but during the creating process, designers also need to think about other psychological facts that can lead this product to success, such as marketing strategies.

### C. Creative in space design

With the help of many neurology researches, we can find out more secrets about human being. One of the definitions of architecture can be found in the Oxford Dictionary of Architecture, which states: "Architecture might be a way of creation and organize chaos (Curl, S. & Sambrook, I., 2000)".

Synesthesia might be the answer for design creativity. The definition of synesthesia is a joining or union of the senses (Cytowic, R. E., 2002). There are many types of synesthesia include color, sound, taste, touch, vision and smell. Over 40% of human has multiple synesthesias (Cytowic, R. E., 2002). For example, when a person who has the synesthesia hears a number, he can link specific color to the specific number. Synesthesia can be passing on by genes. Synesthesia had a long history and has been researched for decades in different academic fields, such as neurology, philosophy, etc. Synesthesia is a special type of work in human's brain. Different senses cross-functioned then generate seems unconnected sensors. Every brain has it

\*Vilayanur Subramanian Ramachandran is a neuroscientist known for his work in the fields of behavioral neurology and visual psychophysics.

\*\*TED is a global set of conferences owned by the private non-profit Sapling Foundation, under the slogan "ideas worth spreading". TED was founded in 1984 as a one-off event.



unique way of functioning. Vilayanur Subramanian Ramachandran \* said in one of his TED\*\* talking said incidence of synesthesia happened on 98 percent people, and it happened on artist, poets and novelists eight times more common. Those people have a great ability to engage in metaphorical thinking because senses in their brain are cross connected. "One thing that artists, poets, and novelists have in common is that they are especially good at using metaphor. For example, it is the East and Juliet is the sun." (Ramachandran, V. S. 2011), and the Figure 18, "Bouba" & "Kiki", shows the synesthesia for vision and hearing. In spatial design field, a tactile-emotion synesthesia was found by Vilayanur Subramanian Ramachandran is very important. He report that, " Evaluators' ratings significantly correlated with the valence of synesthetes' subjective reports, and SCR was significantly enhanced for negative synesthetic emotions. We suggest this effect arises from increased cross-activation between somatosensory cortex and insula for 'basic' emotions and fronto-limbic hyperactivation for more subtle emotions. It may represent an enhancement of pre-existing evolutionarily primitive interactions between touch and emotions" (Ramachandran, V. S., & Brang, D. 2008). Synesthesia is the key that designer creates art and design in association and creation. It is ability that every person have, but artists, designers, and other people have stronger ability than normal people. Readers can understand poetry, but cannot write poetry is same reason. This is the reason that clients and users buy a design service from a design company, even though they can do design either.

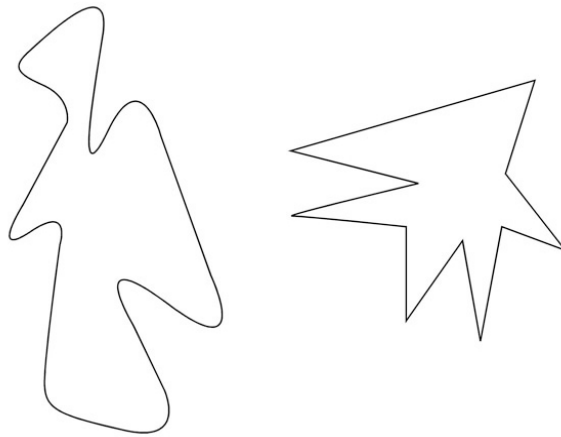


Figure 18. "Bouba"& "Kiki" (Ramachandran, S.,2011)

Synesthesia is an element that helps designers to obtain association. In the article, *Creativity, Synesthesia, and Physiognomic Perception* (Dailey, A., Martindale, C., Borkum, J., 1997) demonstrates that "Synesthesia and physiognomic perception are aspects of primary process thinking...More creative participants differed significantly from less creative participants on their ratings, with more creative participants exhibiting stronger associations between colors and pure tones, vowels, and emotional terms".

Synesthesia, based on human instinctive reaction, can be used to transform people's perception to feelings. For example, the "Bouba" & "Kiki" test is a translation from sound to shape. For designers, design thinking needs to rely on richer multimedia information, rather than depending on a list of design requirements. If the designer plans to design music of an enthusiast's home which is preferred by the master, it may generate some common senses. In other words, the generation of a resonance and contact can be effectively strengthened the deep

understanding of design project, the valid association of design problem solving, and the communication to clients and users. From another perspective, the final design project is a supporting role in human's life, and the best design can integrate into the clients' or users' life.

As I mentioned in the previous part, space design results are related to many aspects such as the tactile aspect, the visual aspect, the auditory aspect, and even to the sense of smelling. To be specific, people prefer to feel the size of the room, touch the sofa material, listens to the sound of tapping between the heels and marble floor, and even the mixed smells of various building materials and so on during their stay. Space design is a collection of ideas that includes function, materials, feeling, memory, and so on. Dr. Richard E. Cytowic's research supports my thinking of space design with the synesthesia. Dr. Richard E. Cytowic, A Professor of Neurology, reports five diagnostic criteria for synesthesia in his book, *Synesthesia: A Union of the senses* (Cytowic, R. E., 2002). Firstly, Synesthesia is involuntary instead of elicited. Second of all, Synesthesia is spatially extended. Thirdly, Synesthesia percepts are consistent and discrete. Fourth, Synesthesia is memorable. Finally, Synesthesia is emotional (Cytowic, R. E., 2002).

In the current society, it is important for life to become a multi-media access to achieve information, entertainment, and communication. People use YouTube to watch videos, Facebook to contact with their friends, and Facetime to make a call. Just in everyday's life, people use a lot of multimedia tools at the same time during their studies and works, For example, project has been used in education space and almost all companies. There will be more newer, and more convenient tool which will continue to be produced. All the designers' needs of required

elements produce Synesthesia, sounds, colors which are existing in our daily lives; and the designers may be able to go through more effective approaches to obtain and feel them.

There are enormous amount of studies done with regards to synesthesia and creativity in the history. For example, Marks in his 1978 research talked about synesthesia and physiognomic between creative people and noncreative people. He stated that creative people make more physiognomic and synesthetic argument, primarily on emotion associate argument, compare to less creative people. Over 25% of the 42 synesthetic studies by (Cytowic, 1989) were artist cases. People who are more synesthetic are more likely to have a profession in art field. Most of studies that researched previously showed there is a cause and effect relationship between synesthesia and creativity. "Evidence suggests that creative individuals have access to primary process modes of thought. Because such thinking is associative, it is believed to enhance the likelihood of a creative insight. Synesthesia and physiognomic perception are aspects of primary process thinking "(Dailey, A., Martindale, C., & Borkum, J., 1997). In fact, the synesthesia and evolutions in design can be understood as a representation of Cross's design process (Figure 19). The logical and leaping thinking of design generated a design solution. Through the repeated comparison design, it tends to get closer to the final result. Quantitative and qualitative changes alternately and repeatedly produce optimal results. As the display in Figure 19, the one-way design development process not only embodies the design process from chaos to clear, but also shows the designer's creative and logical relationship. For example, architect, Ken Yeang, works

on bioclimatic skyscrapers begin from different research in chaos, even he knows five key points is vital (Yeang, k., 1996, Figure 20).

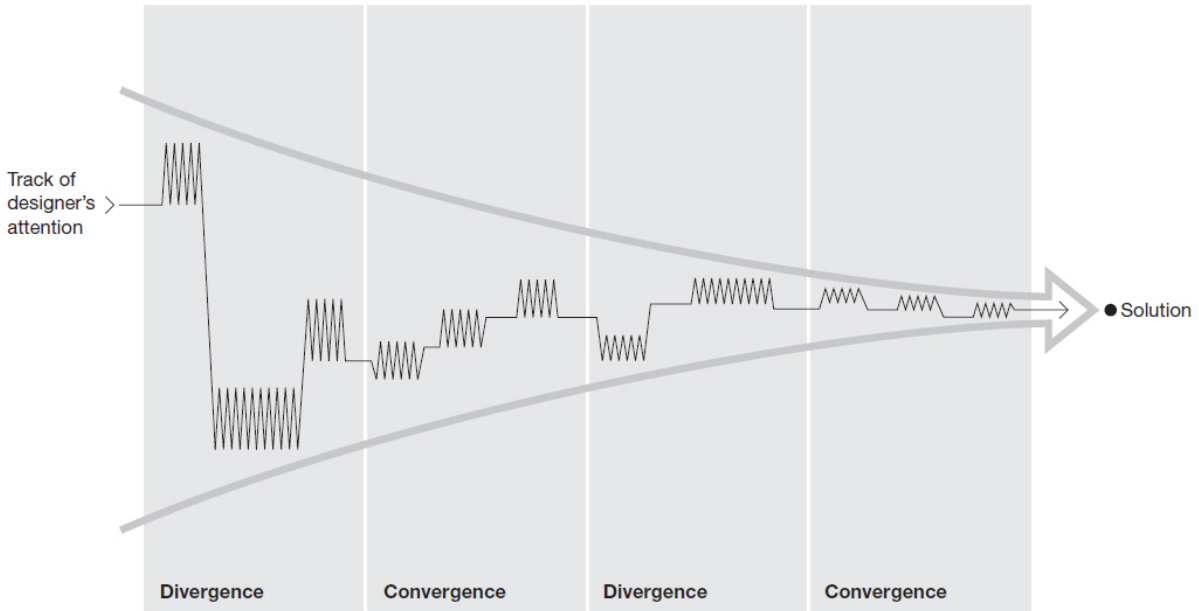


Figure 19, Cross's design process must converge (Dubberly, H., 2005)

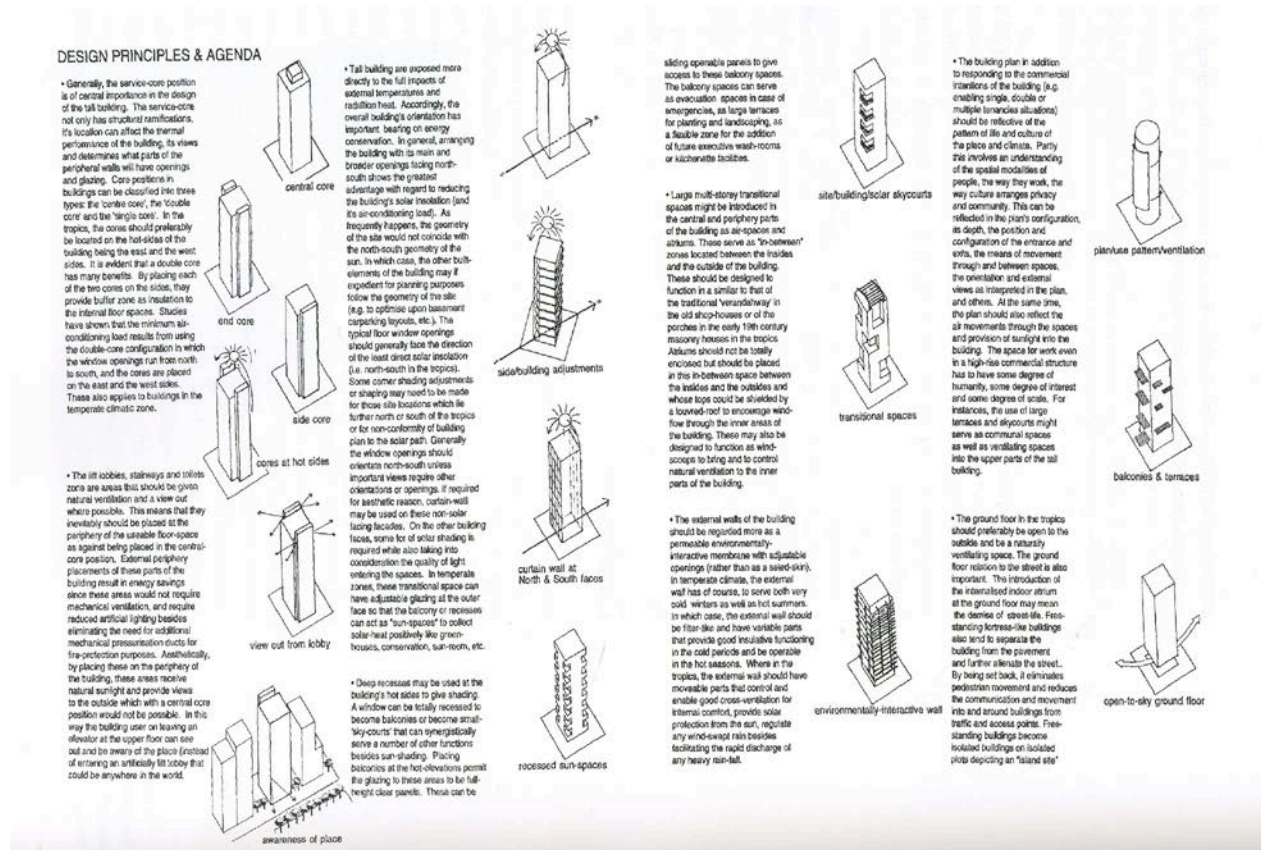


Figure 20, some of Ken Yeang's principles for designing the ecologically sound tropical skyscraper (Yeang, k., 1996)

Hierarchy of Visual Areas shows 187 linkages connect 32 visual cortical areas and areas, and most of them have been demonstrated to be reciprocal pathways. A map to compare and connect design element is the first impression for the figure showed in figure 21. These links represent the connection of physical form, and almost all of the human thinking which is based on this physical structure on the human mind map.

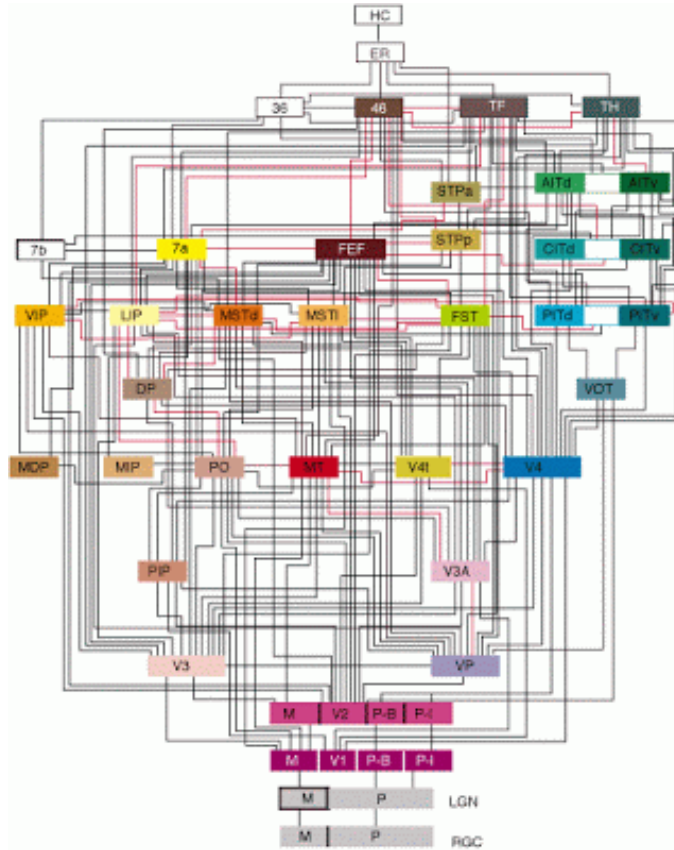


Figure 21, Hierarchy of visual areas (Ramachandran, S.,2011)

In conclusion, design thinking should be integrated because the various features of design work itself. Also, the way of design thinking is rational and depends on subjective reaction from a lot of other designers. Thus, rational thinking, synesthesia from designers, and metaphorical thinking can work together to create a combination of art and craft.

## V. Multimedia design thinking

Comparing design elements and design methods, best design methods should combine in a single and real design program, which always use several design methods for solute design

problem. In addition, the Mandelbrot set model has better secondary effect than the general decision tree model, and combine several design methods to promote design thinking.

#### A. Comparing design elements and design method

A clear analysis of user's needs directs design work. A good design is not a simple purpose in any program. The "good" means works great; the "good" means functional; the "good" means looks beautiful; "good" means smooth finish, and so on. Needs and design result are multifarious in space design. For example, goals of individual space design reflect more personal needs than a commercial space, but commercial and public space need to avoid inconvenient that is better to follow Evidence-Based Design process. Design method is the most important part to direct the creative job to be finished. Actually, the multifarious space design needs are the reason showed in the diverse world. The origin of space design is to satisfy human needs and concert the relationship between the human and natural world as far as possible. It is to not only functioning and using, but also helping people to produce their satisfactions and build human relationships in the society.

Compare with six common space design methods in literate review and other design methods in the universal design field. Classifying the diversity space design needs and change and combining the psychology is a better way to create a space, and do more personality research that has purpose and results about psychology is the main part of space design. Populations have a different purpose and different human psychology of their space, and classify population and their psychological characteristics are the way to build a space for them. Design method can



combine in a single and real design program, which always use several design methods for solute design problem.

## B. Fractal and Chaos theory for visual

The previous article has talked about different design method can be illustrated by logical figures. This is a combination of traditional design method and chaos theory. In fact, every design method can be explained by figure 22. We can find out other information from the same figure, such as connection. As a result, the right part in figure 22 is a final refined product. On the other hand, figure 23 explains the result of design. The right part of Figure 22 and 23 is some in common; they achieve the order through the design process. In the early stage of design, synesthesia and metaphor group together and generate a disorder web, just like the left part of figure 22. Because there are many aspects should be considered in spatial design, those number dots will become more disordered and keep on growing. All the explanations of design method correspond to the definition of architecture, which is the creation of order out of chaos.

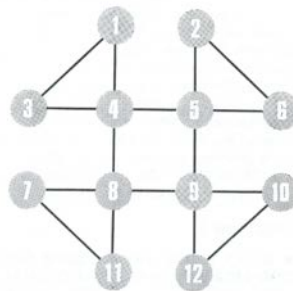
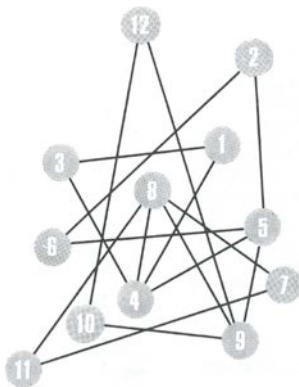


Figure 22, (Jones, J. C., 1992)

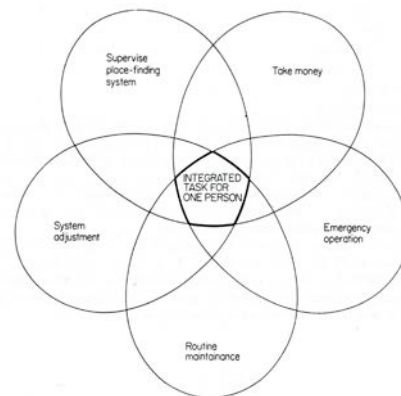


Figure 23, (Jones, J. C., 1992)

Robert F. Woodbury uses three states to reveal a design search process (Figure 24).

These three states are Initial State, Intermediate State, and Goal State. Robert F. Woodbury uses State Transitions to create a simple solution to solve the problem of information relationships. In fact, this system is more complicated, because the designers have to consider many elements from physical and psychological facts which are mentioned earlier. The relationship between various states is more complicated, because it may show a lot of self-contradiction. I believe that the total product life-cycle model for medical device design model (Figure 25) is an excellent example to show the real complexity of the relationship between our designs. With the similar information classification showed by this model, it is necessary for spatial design to consider marketing, quality, concept and other elements and their complex relationship. Prezi can be used to store, display and perform design information. But as the hybrid design method, it continually adding new stuff is not restricted and is more suitable for zoom out and thinks the process as a whole.

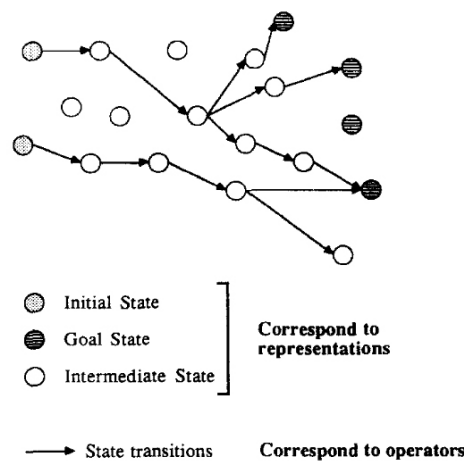


Figure 24, A generic diagram for search (Woodbury, 1991)

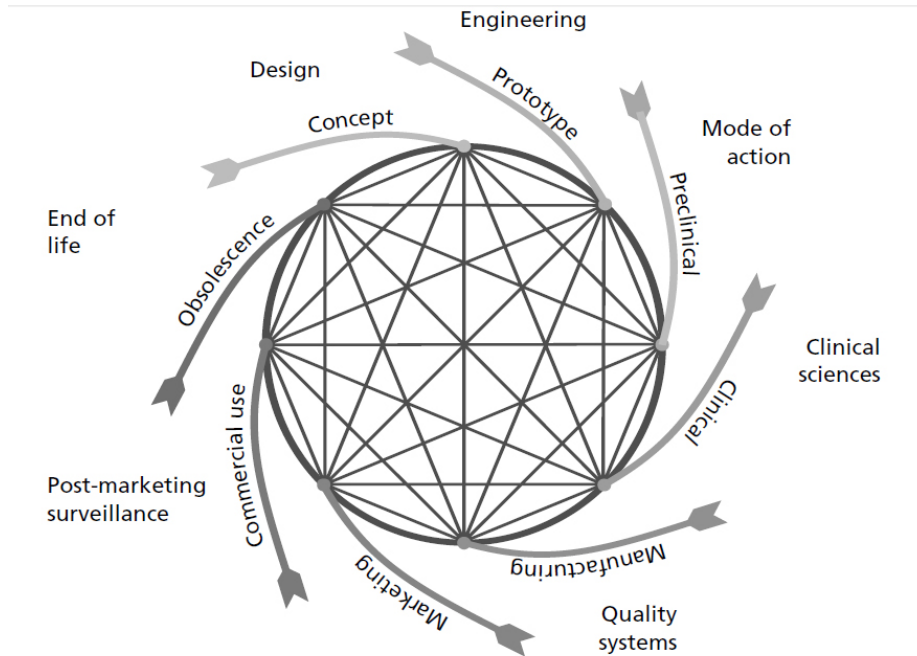


Figure 25, the total product life-cycle model for medical device design (Clarkson, J., & Eckert, C., 2005)

In the book, *Design Method* by John Chris Jones listed three needs for methods. Original work appears for users, solution to a difficult problem or transfers some simple method to solve problems, use creative imagination to overcome rigid origin. Now, let's discuss another topic which is related to the previous content. It is a topic about image. Just like windows in the computer, the design is getting more delicate and vivid. Therefore, does Computer-Aided design rendered image and video.

Let's organize the knowledge we have so far. First, we need to face the elements from physics aspect, multifarious and continuous change need and purpose from users. At the same time, there are thousands of design methods from the perspective of designers. When they face

all the problems, designers' ideas are bouncing though their synesthesia and metaphorical thinking, understanding of their project, and knowledge from education. What a chaos phenomenon and reality. Every factor leads different designers to different design product. For example, for the same competition, participants might demonstrate all kinds of scheme with the same criteria to achieve the same design purpose. It differs like butterfly effect. If a designer changes, it will have a great impact on the design project. Therefore, the design results will be much different. In the design competition, this phenomenon showed why different product would be generated.

Comparing to a general diagram of a decision tree (Figure 26), designers actually use synesthesia to create different nodes for a design project, and make a decision for a project. The associated nodes and branches represent different ways to solve the problems, but the map is not always logical as the designers' demands. For example, the nodes in the bottom may be the first idea, and the Decision Sequence is the second idea. In the ATBAT project (Figure 27), the sketch of architecture design presents a general decision tree system by Le Corbusier. The design problem-solving is created and set out by an order; and then, a decision was elected from the problem-solving.

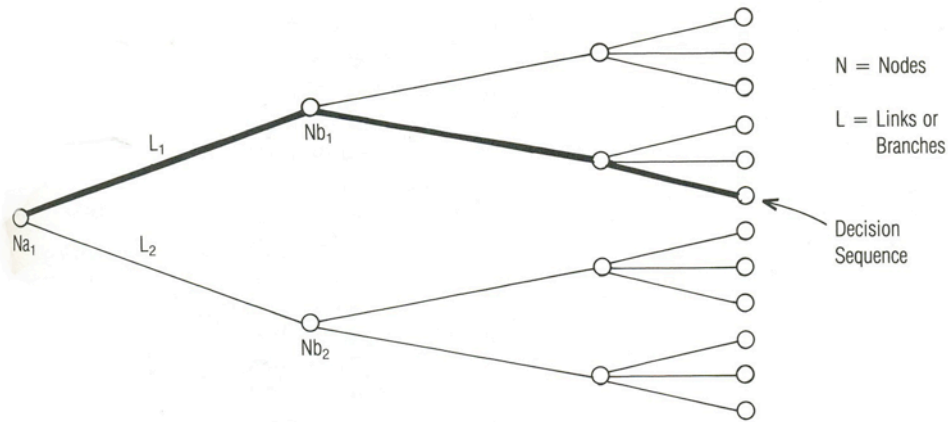


Figure 26, A General Diagram of Decision Tree (Rowe, P., 1987)

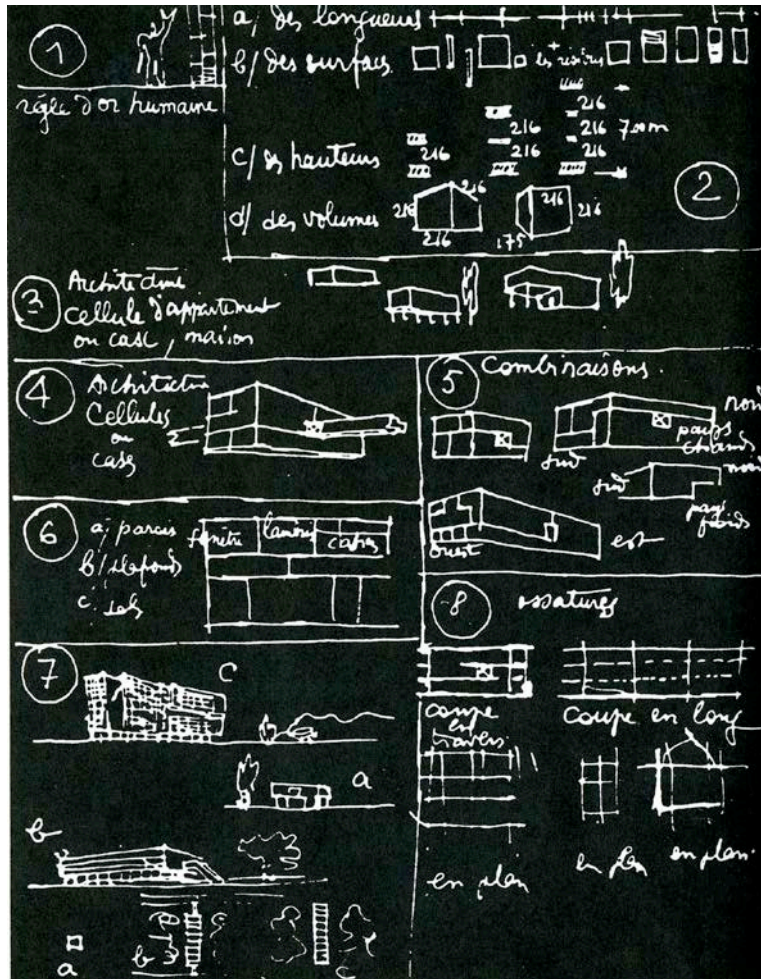


Figure 27, Le Corbusier's guidelines for the ATBAT project (Rowe, P., 1987)

"Chaos made simple" (Kautz, R, 2011) is a title and theory of chaos. All the chaos can be understand, but people use different method to achieve it. Chaos theory is one of them. Chaos theory is a field of study in mathematics, with applications in several disciplines including physics, engineering, economics, biology, and philosophy. Chaos theory studies the behavior of dynamical systems that are highly sensitive to initial conditions, an effect which is popularly referred to as the butterfly effect. Small differences in initial conditions (such as those due to rounding errors in numerical computation) yield widely diverging outcomes for such dynamical systems, rendering long-term prediction impossible in general.

Butterfly effect reflects a way in chaos theory. Chaos theory is a complicate math theory. It has it own model and function.  $z_{n+1} = z_n^2 + c$  is a basic model for chaos theory. Fractal is a Mandelbrot set image demonstration of chaos. "Fractal is a mathematical set that has a fractal dimension that usually exceeds its topological dimension, and may fall between the integers. Fractals are typically self-similar patterns, where self-similar means they are "the same from near as from far" (Mandelbrot, Benoît B., 2004). The Mandelbrot set (figure 28) illustrates self-similarity. Every zoom in can find the same figure as the large one. The entire small-scale figure can seem as "Little copies" of the whole image (Tan, L, 2000). Chaos theory and Mandelbrot Set for architects and designers may be very strange, but they derived a mathematical calculation, Fractal, has been widely understood. In the book, *Fractal Architecture: Organic Design Philosophy in Theory and Practice*, architect Harris discusses the role of fractal geometry in architecture form and facade design (Harris, J., 2012).

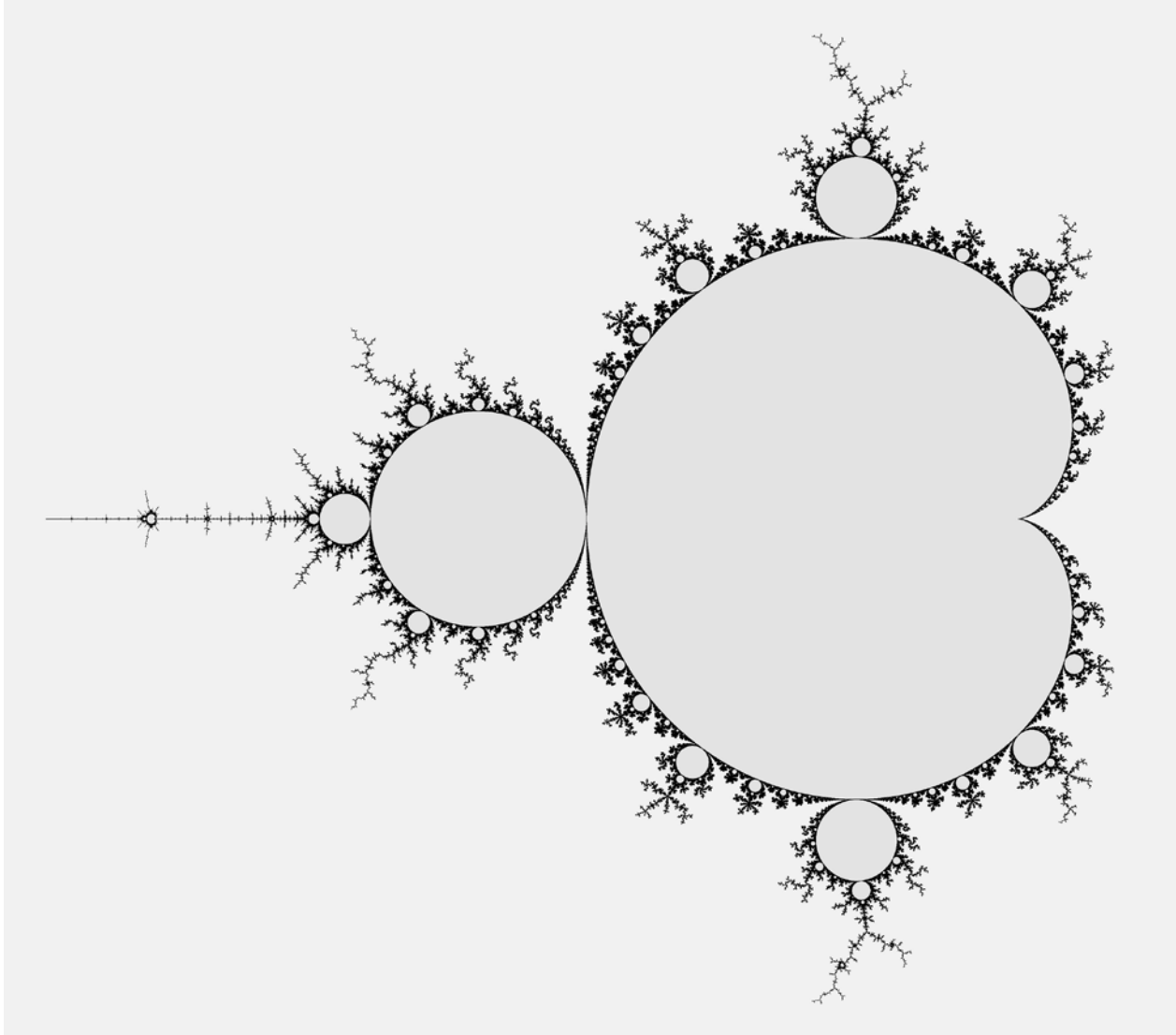


Figure 28, Mandelbrot set (Tan, L, 2000)

In the cycle of this circumstance, it showed a philosophy principle about repeating and relearns the whole entity, because every little copies are the same. Now, let's go back to the perspective of design method. Introspection of design is also the process of reviewing and rethinking. Archers' design method can apply on this figure as well. Every calabash shape individuals contains all the elements that we need in the design process which include physical

factors and analysis results. In that way, every little copy also contains complete content. The junction between main part and fractal is the aspect of thinking or the result of synesthesia and metaphorical thinking. For example, the circle part in the figure 28 represents sustainable, the whole figure can be viewed as the development of tree diagram. The main difference is the little copies and main part have equal amount of information. In other words, on the basis fractal of the Mandelbrot set, designers can create a new process of design that differs from Archer's process. It combines the feature of inner loop and tree diagram. The Decomposition - recombination (Figure 29) system demonstrates the complexity of design and the relationship hierarchy, while the Fractal become the ideal two-dimensional way of thinking and displaying methods. To consider the details of the design as a problem, it is equivalent to introduce a new design problem. In fact, it is extremely important for designers even though the problem is associated with design details.



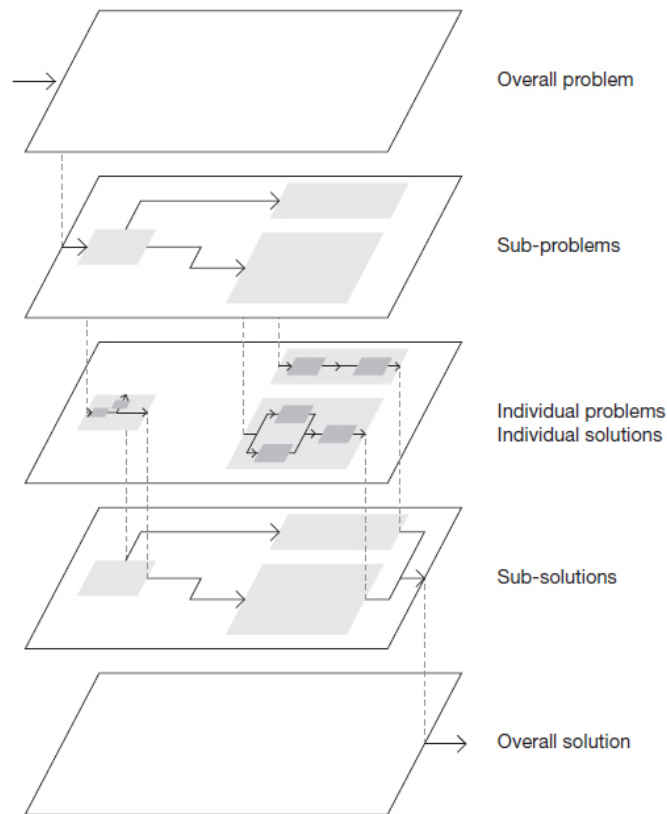


Figure 29, Decomposition - recombination system (Dubberly, H., 2005)

Comparing to a general diagram of a decision tree (Figure 26), the Mandelbrot set entirely is the advanced version of the general diagram of a decision tree. There is a very clear order of ranking related to the Mandelbrot set, similar to the letter grades, numerical rating of the general decision tree. However, Mandelbrot Set has an unparalleled advantage which is to expand the information. Comparing to A General Diagram of Decision Tree (Figure 26), the individual part named "little copies" in the Mandelbrot Set (Figure 28) can be more logical and efficiently arrange thinking process, more than focusing on the point-to-point thinking mode. The advantage of Mandelbrot Set is to magnify the general decision tree nodes. In Mandelbrot

Set, it is easier to understand it based on examples if the initial primary graphics can be understood as Na1 in Figure A General Diagram of Decision Tree (Figure 26). Firstly, in a General Diagram of Decision Tree, it is a process to find their own favorite one in an album from Na1 to Nb1. The design thinking is a particular chaos state in the initial stage; in Mandelbrot Set (Figure 28), the process of developing from Na1 to Nb1 is like a promise to find their favorite one on the wall plastered with many photos. The expansion not only increases convenience, but also reduces the risk of missing essential information. Bryan Lawson side, "For me creativity is, you know, finding solutions for all these things that are contrary, and the wrong type of creativity is that you just forget about the fact that sometimes it rains ... " (Lawson, B. , 2006). In a General Diagram of Decision Tree in, the process of tracing Nb1 back to a series of Na1 is to gather many assemble page papers back into a thick folder. In Mandelbrot Set, Nb1 back to Na1 is to put a compiling paper into a reasonable order, and to be flatted on the desktop. This reverse process of design evaluation step is very important for all of the design thinking.

In conclusion, through analyzing design methods and thinking process, mathematical model studies, and related to the purpose and definition of spatial design; the Mandelbrot set model has better secondary effect than the general decision tree model. In the design process, the expression of two-dimensional figures in spatial design can be illustrated by the cycle of mathematic model to generate the method of spatial design.

## **VI. Finding: Spatial design thinking from Mandelbrot Set and software support**

Now, we can think about design methods from the perspective of young designers. The concept ranges from anywhere in the multiple state special design map, and young designers have some new traits due to being part of generation Y. The generation characteristics comparison chart (Figure 9) is better at showing the changes for young clients and designers. Designers need a new method and design process for the new characteristics. Designers have been using more and more Computer-Aided design software and other auxiliary equipment in today's society. For example, 3D printing device in Autodesk design software replaces the traditional model in many design processes. With the development of science and technology, the realistic model becomes less necessary in design process rather than the computer model. Back to the problem of design thinking, the question is whether we use the new technology? The answer of course is yes. Computer-aided design method is the right direction, and almost all of the design software can be converted to connect to each other by mutual turn to achieve the best results. Computer-Aided design has already helped designers to solve their problem, although there are details that still need to be worked on.

Through the analysis above, we could get a mathematical model. Not only it can be visualized, but also reflect the basic design logic. There characteristics of visualization and intelligence can connect and meet the requirements for the new generation designers. Based on the knowledge of visualization, more beneficial outcomes can be made through multimedia. Therefore, more inspiration is generated to help designers when they lack ideas. Everything

sounds wonderful; however, we need to find something to achieve this visual multiple design method.

A. Prezi as basis, due to of its characteristics.

There are a lot of ways to enforce visually Mandelbrot set for design thinking. Must say that the generation and logic of the design both are derived from human and knowledge of spatial design education. However, another helpful possible solution is Prezi. The definition of Prezi is that a presentation tool to help people to organize and share their ideas; and Prezi also can be used in design thinking process as a Computer-Aided tool because Prezi and Mandelbrot have some common characters. In addition, Prezi has more advantages in the multimedia-assisted field to help designers, clients and users to be associated with a design project. Peter Arvai said "Prezi can help you to create a map of points, structure your ideas, see overview and details at the same time. Throw in you keywords, images, videos, arrange and find out what you want to say" (Arvai, P. n.d.).

First, I use the traditional method to explain the possibility of Prezi. Prezi is a software can be use for collaborate and presentation; it is a virtual platform, which contains many bubbles. Each bubble works just like the slides in the Powerpoint software. It uses zoom in and zoom out interface to display multimedia information. The bubble of Prezi can move, rotate, scale, and can produce more changes in the time dimension. In such a free interface, Archer's design stage can be arranged and cycle to show step-by-step of the design process of the kind of self-loop process.

Evidence-based design tends to display a one-way process of thinking logic diagram or like divergence connection in brainstorming. The most important thing is it completely complies with the Iconic design process. These features completely screened the Mandelbrot Set characteristics so that Prezi has a good platform and potential to operate as a design platform. Certainly, the advantages of Prezi are far more than these points.

Secondly, visualization and multimedia-assisted design is the important for designers. Multimedia interface can generate more metaphorical thinking and imagination. All of the design analysis, draft drawings, videos, pictures, images from internet and related information can be displayed on Prezi. In the design process, all of the design information is stored in a huge canvas; this is conducive to the association and to avoid forgetting. "Zoom out" on Prezi is equivalent to multiple drafts arrange and display on a platform, including photographs and design comparison, etc. In the traditional process of design, Prezi interface can display more multimedia content, and zoom in is equivalent to focus on the details of the individual aspects. In the process of gathering traditional information, designers use a lot of methods to collect data from more squarely within architectural realm experience. For example, the references from iconic analogies, the Hans Hollein's sketch, and elements of a narrative scenario (Figure 30), are scenarios for the Ringturm Travel Agency in Vienna (Rowe, P., 1987).

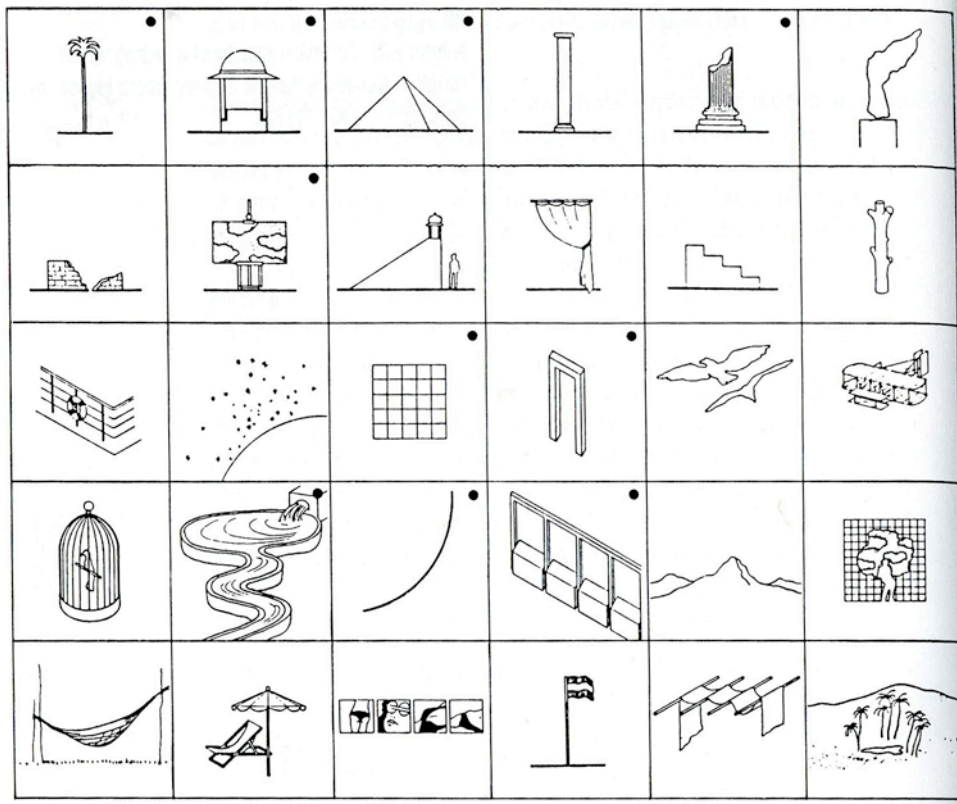


Figure 30, Elements of a narrative scenario (Rowe, P., 1987)

Thirdly, for those who like technology products and does not like face-to-face in-person communication, Prezi is a new and effective communication tool because it does not need an appointment to communicate between clients and designers and eliminate the time of transportation. Designers can make a little change to turn the interface on Prezi into a presentation. Spatial design project is created by Prezi which can be co-edit and presented in anytime by any person. The Prezi Company reports that Prezi provides you the power to create and edit with others in real time. Each Prezi enables you to invite others to collaborate, brainstorm, and present the process of using the same zooming canvas (Prezi Inc., n.d.). The

Generation Y overwhelmingly likes the Characteristics because young people are 24/7s, and they grew up accompanied with the technology development and live in a mobile internet era.

Finally, designers can just send the Prezi design draft to the clients, users, colleagues, builders, and so forth. And then, they can discuss, modify, and add content based on their demands. Almost every space designer believes that communication is overwhelmingly significant in the design process. Nigel Cross even defined that communication is the most important design in one of the four design steps (Figure 31). In the process of a communication, the designer can not only figure out design goals, client's needs, and client's feedback, etc., but also activate the advance of design process. In the book named design process and communications: from a case study (Straub, C., 1982), Calvin Straub classifies three groups of communication steps in a whole building process which is from the project development to the recoding of a project. Although the traditional way of communicating with a design project can meet the design objectives, design process can be more effective if designers use Prezi.

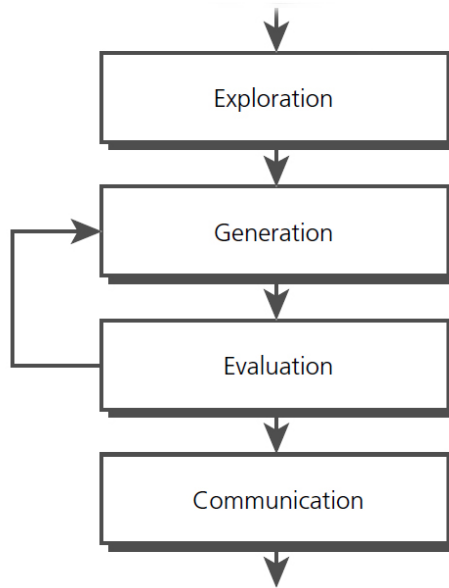


Figure 31, Cross's model of design (Cross, 1994)

In conclusion, a flexible and diversity design method and tool that following design method, human mind, mathematical principia, human characteristic of young generation is becoming more necessary for young designers, and it can be used to build better space context for designers thinking.

#### B. Use Prezi in spatial design

Prezi file (Figure 32) can arbitrarily enlarge, shrink and rotate the interface characteristics, and at the same time fully comply with the Iconic model of a design process organize your thoughts. Many of the details of the design method can be used as auxiliary tools.





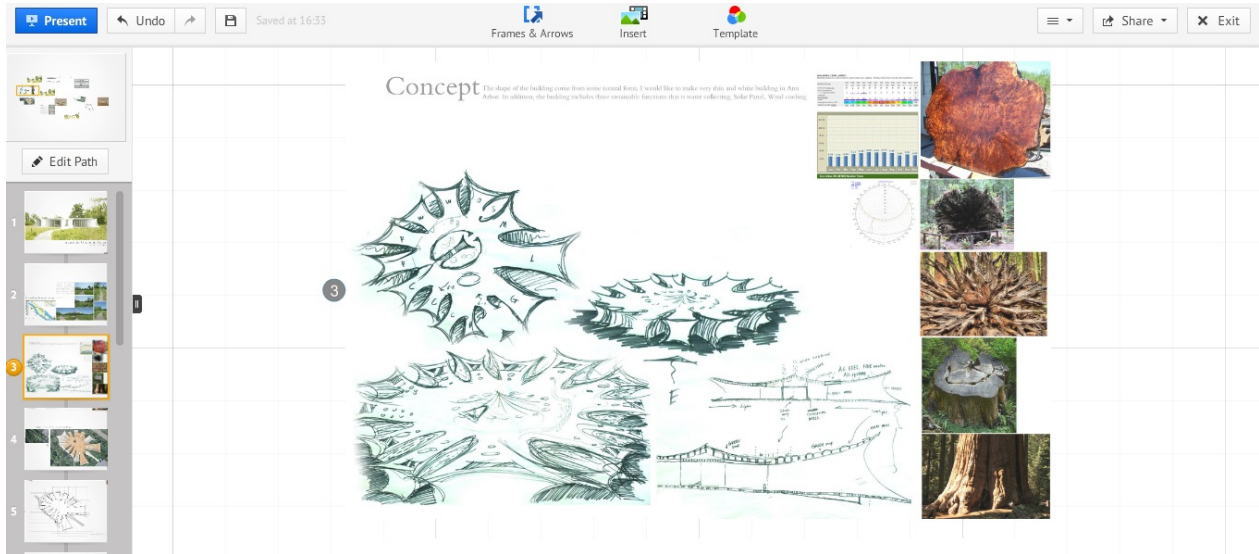


Figure 33, Prezi canvas shows pictures and text

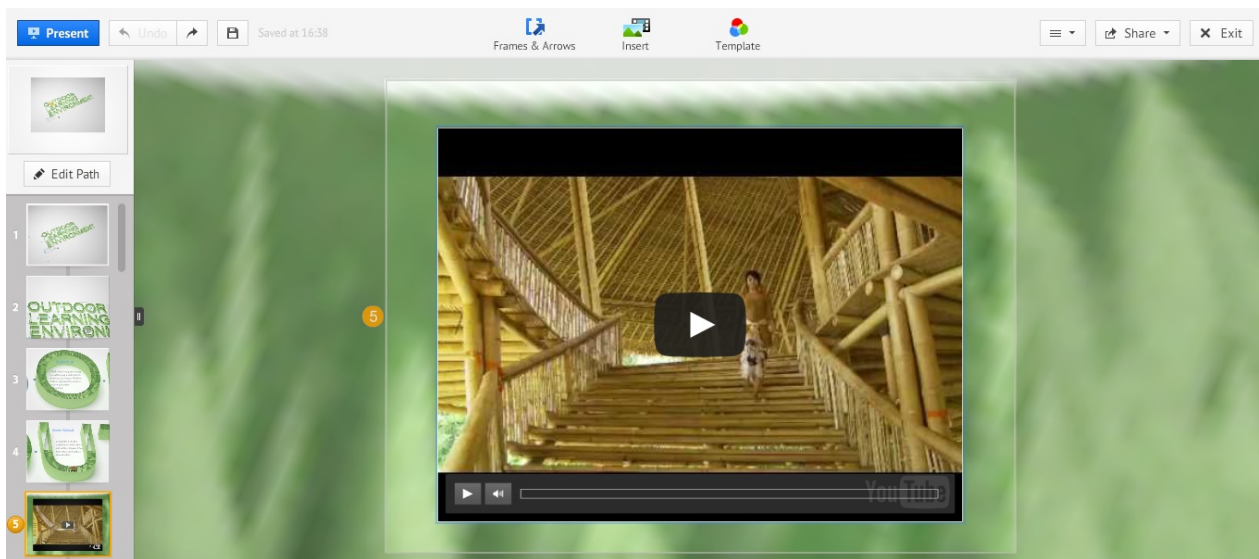


Figure 34, Prezi canvas shows video

2. The completion of the synthesis part of the content (Figure 33, 35) including the originally formed aggregation and continue to organize the existing aggregation (using Archer's DESIGN method). As displayed (Figure 24), the disorders in the process become orderly. But in

fact, in the last step, the process of collecting information were finishing. Because the aggregation characteristics, the aggregation of information arranged in a certain order has been shown.



Figure 35, Stage in Prezi canvas

3. Zoom in and zoom out of the way of thinking have some relationship with metaphorical thinking and synesthesia. This is the advantages of graphical and multimedia. Zoom out process can be understood as a return to fundamental things in order to thoroughly thinking. Straighten out all the information in accordance with the order of evaluation is to comply with the Iconic design process of judgment and evaluation. Compared to traditional design tools, paper-and-pencil or computer, Prezi can provide a more simple experience, at the same time designers could have more time to think about other ideas, rather than find drafts, books and other things. The integrity is very important, because it is a complete observation overall process. This process is complicated in the conventional design, which is very easy for Prezi to implement. Although the overall diagram might not be very clear, its main purpose is to

let designers not tangle in the details. If there is a question, designers can zoom in to find information that is more detailed. About the function zoom in and zoom out, it is a very normal function for designers, and even can be demonstrated that this is a habit of action. In almost all of the Computer-Aided softwares, designers use the scroll wheel on their mouse to achieve the function of zoom in and zoom out such as the Autodesk CAD, the Autodesk 3D Max, the Autodesk Revit, the Google SketchUp, and so forth.

4. Thinking structure can be added to other design methods to continuously. For example, if designers want to use Evidence-Based Design, they can analysis it in the content. These content just like little copies of the fractal. This is a design method of utilization. For designers, spatial design methods are often used in a mixed way because the different design methods have their separated focuses and outcomes. There is more than one spatial design method which can complement with each other because a large number of the design methods have the similar logic. Comparing to the Archer's model of the stage of a design process (Rowe, P, 1987) and Evidence-Based design, there are many based analyses which are exactly the same thing. The site analysis is a suitable example to explain this issue.

5. Using Prezi to communicate. Prezi is a tool for communication, collaborate, and presentation, because its interface is to be able to share it to other users. The more visual communication in the design process, more efficient the design process will be. The Prezi Company reports that Prezi is easily to be used to share your ideas with your clients, colleagues, classmates, and the world. Co-editing in real time, and from across the room or across the globe

are also the characteristics (Prezi Inc., n.d.). Spatial design work is used to almost provide all the daily work for people, study and life services; and the communication features of Prezi is to effectively understand clients and users' ideas and suggestions.

6. If the Prezi use in space design, their final result like a generation of a sketch on the canvas, or a series of images and text results. It may be a sudden creation or a synthesis of the information obtained in the process of analysis and understanding. Just like a single point or a combination of a series of points.

In conclusion, the Prezi design support tools is a new design thinking and tool that is different from a traditional design methods and thinking process and independent design method. It depend on the important space deign characteristics, diverse design purpose, and different design method can be used as an assistant. Design methods are the result of logical thinking, plus the result of the relationship is the reason plus reflection. Like  $1 + 1 = 2$ , basic and simple. Apply a mechanical way of thinking as well as more flexible combination and seek visualization and the deeper internal links, as applied Prezi. New ideas in Prezi not restricted because of the designer's thinking are not in accordance with the Archer's design process specification. People will think and synesthesia, if the combination of the two of them can be completed in a design. Find design elements that can suit clients' needs and balance design purpose and design element using is a feasibility research. In a real design process, designers should balance more elements for a project.

## **VII. Advantages of spatial design thinking and tool**

Spatial design thinking and tool that use Prezi is not a brand new design methods in theory, but max them is different with a traditional design process, and stands independently as a design method because it works better to create and associate through perspective of designers and communicate with clients and users.

### **A. Relationship between literature and theory**

The spatial design thinking and tool that use Prezi is not a brand new design method in theory, but it that is different with a traditional design process, and stands independently as a design method. It dependents solely on the importance of space design characters, and diversity design purpose. The diversity design method can be used as an assistant. In addition, the new design method as use Prezi shows more choice than a step by step design process. In fact, the complete systematic design is impossible because things are interrelated, and most of them are not linear.

In the next paragraphs, all the definitions and relationships will be showing for the diversity of space design. A well-balance benefit and outcomes that is workable and brings in more diversity to build my model as it can be split to the normal design method. Compositions of traditional design methods are far more interesting, logical, and straightforward.

### **B. Relationship in practice**

1. Material collection and communication feedback between users and designers

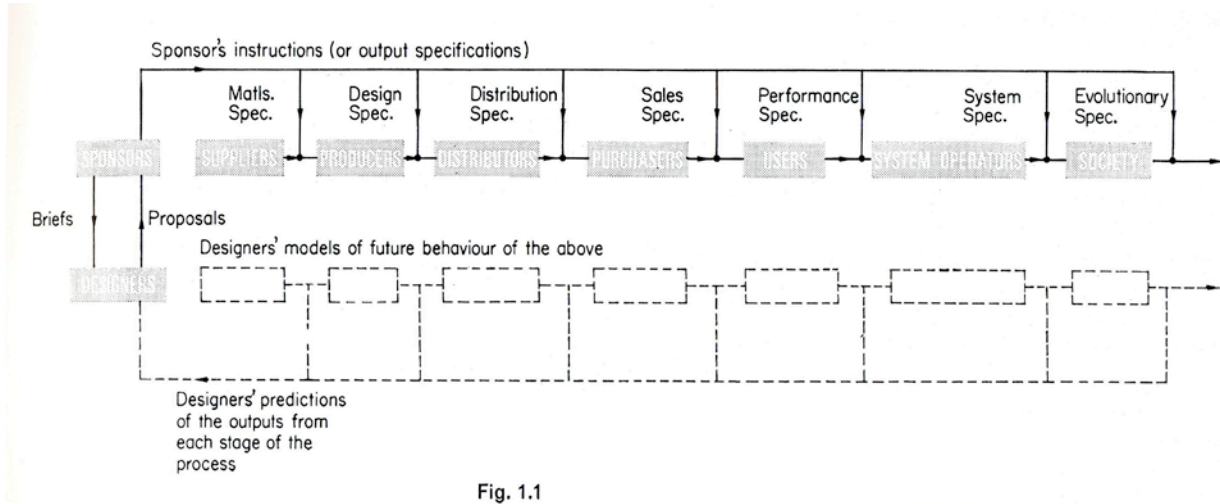


Fig. 1.1

Figure 36. Sponsor's instructions & signers' predictions of the outputs from each stage of the process (Jones, J. C., 1992)

This diagram (Figure 36) explains the nature of the design, and one-to-one relationship between results and objectives. Designers should first work through communication to establish the corresponding target. In addition, designers need to design using their existing knowledge. Better communication is necessary. Since each client is different, they must have good communication skills in order to achieve a relatively ideal design results. In the book, Prezi is able to help designers achieve this aim, at the same time also more suitable for young people. In the book named design process and communications: from a case study (Straub, C., 1982), Calvin Straub classifies three groups of communication steps in a whole building process which is from the project development to the recoding of a project. Prezi is a tool to create and edit

Prezi project together with up to 10 co-editors and 30 attendees in real time (Prezi Inc., n.d.). For some spatial design projects, the amount of 40 people is a big number which displays the communication with clients and users, designer, constructors, and the builders.

## 2. Better creation and association through perspective of designers

Better creation comes from the freedom to create and build design links and relationship with a wider viewing angle and zoom out in at a timely manner. Paying attention to detail, and thinking from the overall situation is crucial for a designer. This is just like the idea of integrated design thinking and process. The zoom in and zoom out action have become a habit in other Computer-Aided software by designers. Synesthesia is way that people use to join or union senses and thinking.

In conclusion, Prezi is a useful tool for designers and design projects because it is a tool work for both thinking and communication.

## **VIII. Discussions and Conclusion**

The multimedia spatial design thinking and tools such as Prezi are feasible and helpful for designers, client users, builders, and so forth. It is an important and handy tool for design thinking throughout the process of thinking, communicating, and building. This multimedia tool, Prezi can help the entire design participant to do thinking, associating, and creating, and communicating.



On top of being an extremely helpful tool, Prezi adapts better to the characteristics of the younger generations, which including various new features, new technology applications, personalized requirements, and convenient communicate system. In addition, it is in line with young people's habit of collecting and processing information in multimedia during this internet era since the subjects of space design users, goals and materials for space design are multifarious and changed very fast. The multimedia spatial design thinking and tool as Prezi meet the needs of many spatial design thinks, and it is also consistent with all of the space design methods. It has taken into account of the characteristics of humans today which include diverse features, the application of new technologies and materials, the personality requirements, and their communication needs.

Synesthesia is a key to help designers to obtain association. Spatial design thinking should be integrated because the various features of design works for itself. Also, the way of spatial design thinking is rational and this thinking depends on the subjective reaction. Thus, rational thinking, synesthesia from designers, and metaphorical thinking can work together to create a combination of art and craft. The spatial design thinking follows the mathematic logic. Through analyzing design methods and thinking process, the mathematical model studies are related to the purpose and definition of spatial design; and the Mandelbrot set model has better secondary effect than the general decision tree model. In the design process, the expression of two-dimensional figures in spatial design can be illustrated to generate the method of spatial design by the cycle of mathematic model.

A research about space design thinking is not only a complicated and interdisciplinary research about designs, but it also needs to reflect more information about the research participants. In the field of Computer-Aided Design, user designs depend on the development of information technology, and a significant amount of auxiliary software are used in promoting efficiency. On the other hand, design thinkings related to combined deep-seated human mind and thinking systems is relatively scarce. Many of the related researches and the neurological researches are still subsequently revolving at the starting and guessing phase. In this current multimedia era, the younger generation is the leader; space design thinking need be altered for their need. Comparing to previous studies on the spatial design thinking, this research is about the start of spatial design thinking with focuses on comprehensive and time-sensitive, and from the participants' perspective.

This research about spatial design thinking and multimedia is very important and useful for all the spatial users, clients, designers, and builders because it finds the way that accords with design approaches of thinking and habits to auxiliary design thinking processing, communication processing, and building processing. On the theoretical side, this research combined space design, neurology, mathematic, and multimedia knowledge to develop design thinking and methods, and originate design thinking from analyzing and understanding of the basic human mind. In addition, this research will introduce a very helpful multimedia design aid, Prezi, which values the designer's thinking and perception.

For more information about this research, a number of related disciplines research results

have been used, and comparing and analyzing these results to the existing design methods. In the field of spatial design, several rational design methods and thinking processes have been used, however, this research expands further into the design process of association and creation, with examples such as, human synesthesia and creating, new generation and multimedia, and so on. Also, this research incorporates multimedia design support with the traditional design process.

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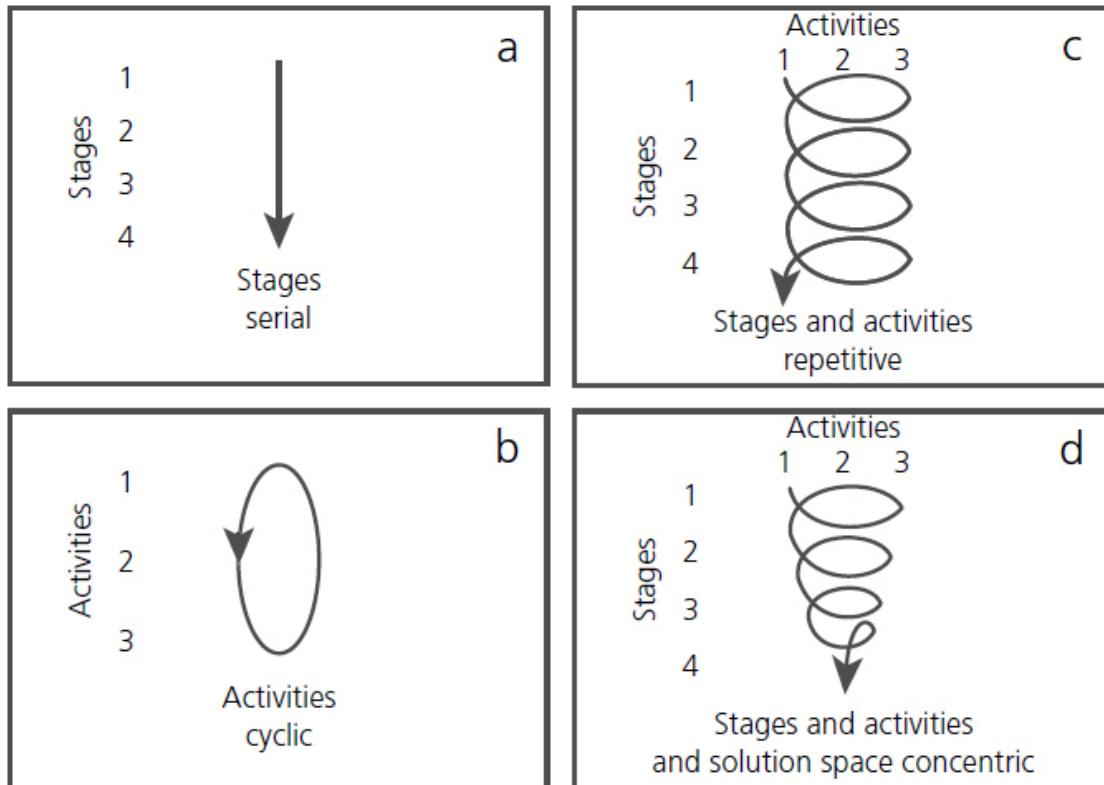
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## Appendices 1

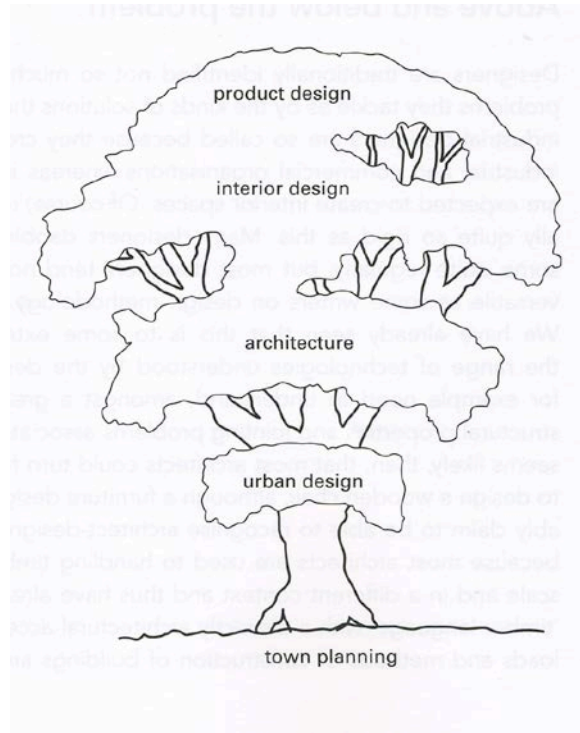
Figure 1, Four typology of design models (Blessing, 1994)





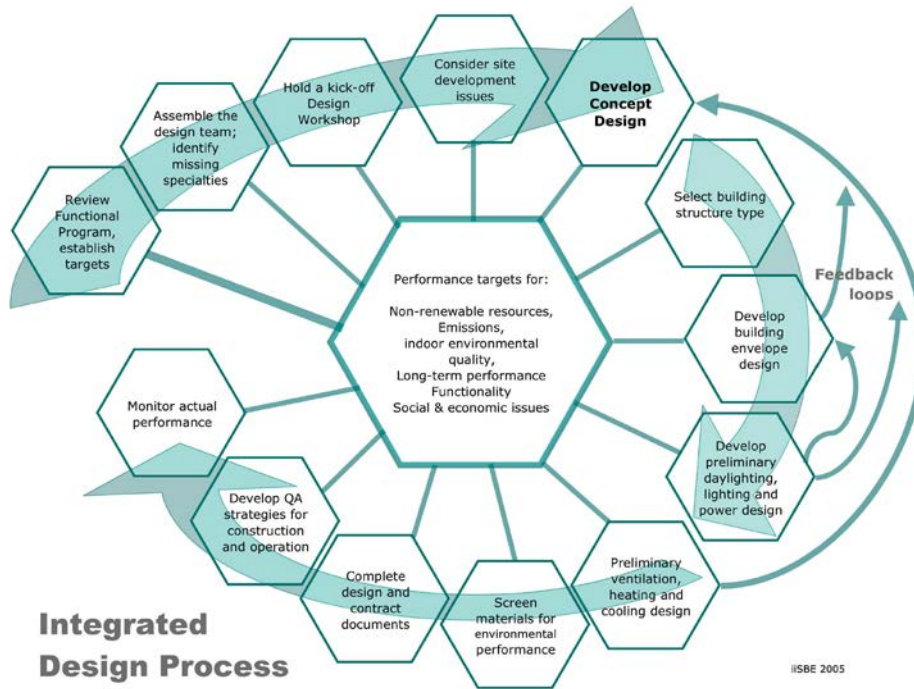
## Appendices 2

Figure 2, a "tree" of three dimensional design fields (Lawson, B., 2006)



### Appendices 3

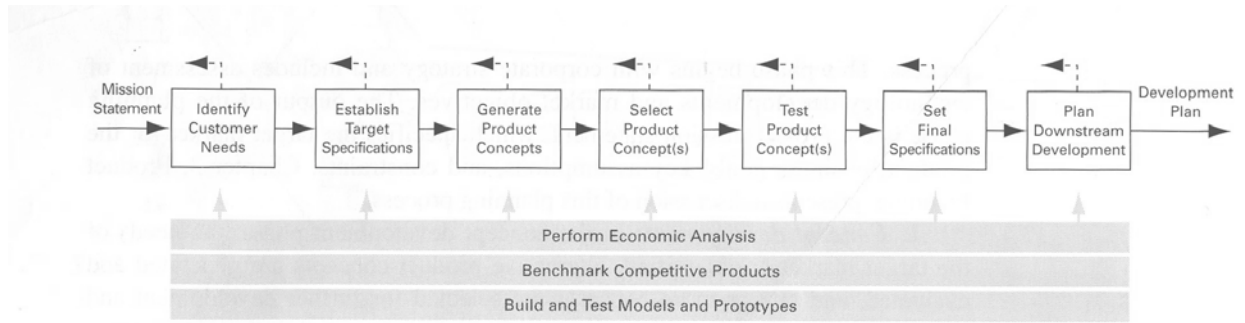
Figure 3, Integrated Design Process (Larsson, 2004).



## Appendices 4

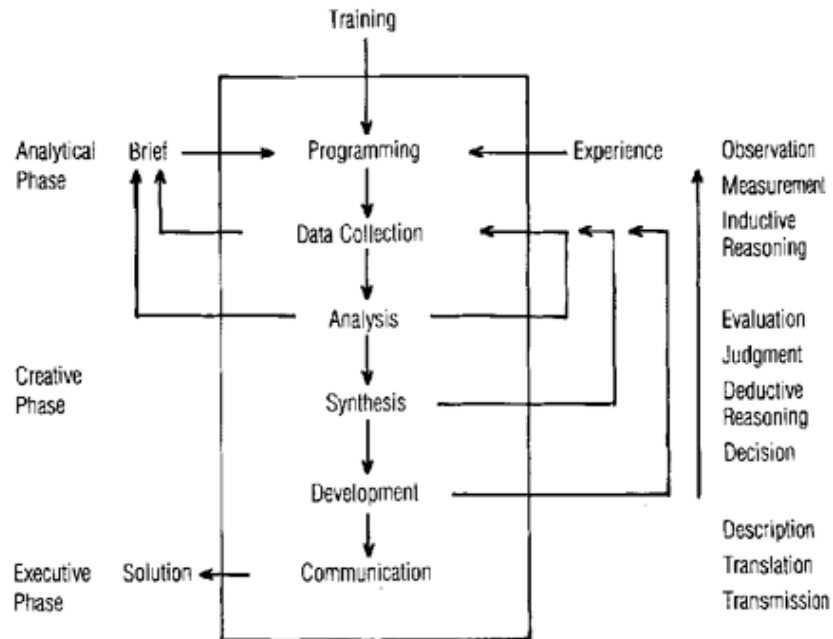
Figure 4, Front-End Concept Development Process (Ulrich, K. T., & Eppinger, S.

D.,2000)



## Appendices 5

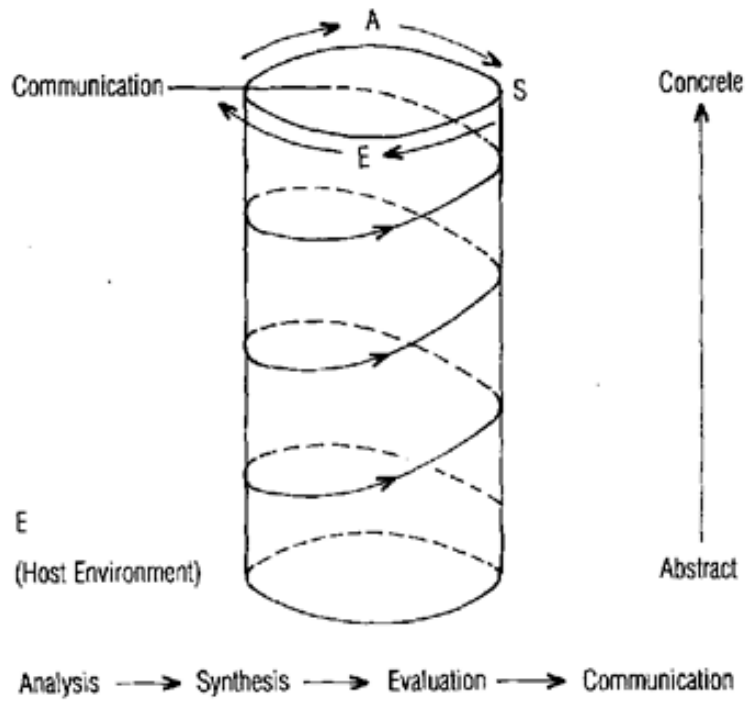
Figure 5, Archer's model of the stage of a design process (Rowe, P., 1987)



Archer's model of the stages of a design process.

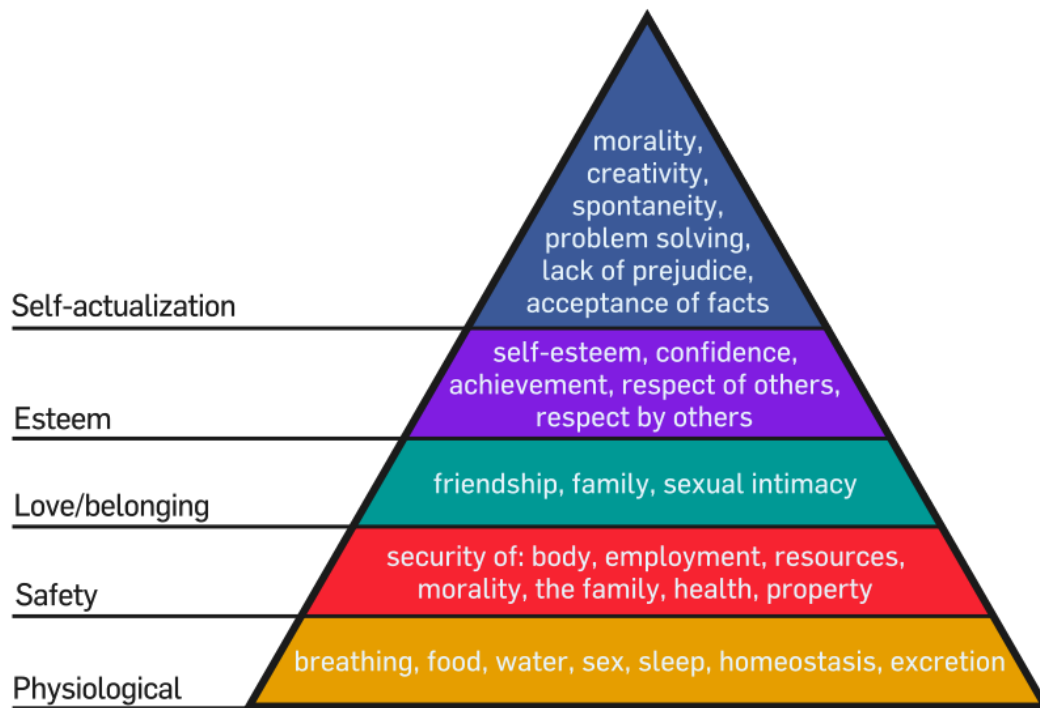
## Appendices 6

Figure 6, Iconic model of a design process (Rowe, P., 1987)



## Appendices 7

Figure 7, Maslow's hierarchy of needs (Simons, J. A., Irwin, D. B., & Drinnin, 1987)



## Appendices 8

Figure 8. Median and Average Square Feet by Location (U.S. Department of Commerce, 2013)

**Median and Average Square Feet of Floor Area in New Single-Family Houses Completed by Location<sup>1</sup>**  
(Medians and averages computed from unrounded figures)

Year	Median square feet							Average square feet						
	United States	Inside MSAs	Outside MSAs	Region				United States	Inside MSAs	Outside MSAs	Region			
				North-east	Midwest	South	West				North-east	Midwest	South	West
1973	1,525	1,625	1,380	1,450	1,445	1,555	1,575	1,660	1,760	1,490	1,595	1,615	1,670	1,715
1974	1,560	1,665	1,405	1,465	1,490	1,640	1,540	1,695	1,785	1,545	1,600	1,660	1,760	1,660
1975	1,535	1,630	1,365	1,405	1,460	1,605	1,510	1,645	1,735	1,490	1,575	1,580	1,705	1,635
1976	1,590	1,675	1,425	1,505	1,495	1,660	1,565	1,700	1,775	1,560	1,630	1,655	1,755	1,685
1977	1,610	1,705	1,440	1,540	1,540	1,660	1,615	1,720	1,795	1,565	1,650	1,650	1,770	1,730
1978	1,655	1,735	1,490	1,640	1,615	1,685	1,630	1,755	1,830	1,610	1,730	1,730	1,785	1,740
1979	1,645	1,735	1,485	1,690	1,605	1,675	1,625	1,760	1,845	1,605	1,795	1,720	1,795	1,730
1980	1,595	1,670	1,450	1,660	1,520	1,615	1,570	1,740	1,825	1,575	1,770	1,685	1,750	1,735
1981	1,550	1,650	1,415	1,655	1,480	1,540	1,580	1,720	1,820	1,535	1,805	1,670	1,715	1,735
1982	1,520	1,600	1,355	1,605	1,405	1,500	1,595	1,710	1,795	1,545	1,755	1,655	1,700	1,740
1983	1,565	1,610	1,445	1,650	1,515	1,565	1,545	1,725	1,785	1,570	1,795	1,735	1,720	1,695
1984	1,605	1,645	1,495	1,665	1,600	1,590	1,610	1,780	1,840	1,600	1,860	1,800	1,750	1,785
1985	1,605	1,655	1,445	1,655	1,625	1,590	1,595	1,785	1,830	1,610	1,830	1,820	1,765	1,770
1986	1,660	1,700	1,470	1,695	1,685	1,655	1,635	1,825	1,865	1,640	1,850	1,855	1,825	1,800
1987	1,755	1,800	1,565	1,840	1,740	1,755	1,730	1,905	1,950	1,700	1,955	1,890	1,915	1,870
1988	1,810	1,880	1,570	1,810	1,840	1,790	1,845	1,995	2,055	1,750	2,005	2,015	1,985	1,995
1989	1,850	1,920	1,570	1,870	1,800	1,815	1,910	2,035	2,105	1,750	2,075	1,970	2,030	2,065
1990	1,905	1,985	1,630	1,955	1,850	1,855	1,985	2,080	2,155	1,800	2,105	2,005	2,055	2,160
1991	1,890	1,970	1,635	1,950	1,800	1,870	1,980	2,075	2,155	1,815	2,105	1,990	2,065	2,155
1992	1,920	1,990	1,700	2,000	1,870	1,945	1,890	2,095	2,160	1,870	2,115	2,020	2,130	2,090
1993	1,945	2,000	1,700	2,050	1,855	2,000	1,845	2,095	2,160	1,860	2,160	2,025	2,150	2,050
1994	1,940	1,995	1,700	2,035	1,850	2,000	1,835	2,100	2,160	1,865	2,195	2,025	2,165	2,025
1995	1,920	1,975	1,720	2,095	1,850	1,945	1,835	2,095	2,150	1,870	2,240	2,020	2,125	2,045
1996	1,950	2,000	1,735	2,100	1,900	1,995	1,890	2,120	2,170	1,915	2,280	2,025	2,160	2,070
1997	1,975	2,015	1,765	2,130	1,900	2,000	1,930	2,150	2,200	1,955	2,265	2,065	2,175	2,135
1998	2,000	2,050	1,750	2,100	1,945	2,000	1,985	2,190	2,250	1,930	2,270	2,125	2,200	2,200
1999	2,028	2,089	1,811	2,175	1,937	2,044	2,001	2,223	2,274	1,991	2,298	2,135	2,244	2,234
2000	2,057	2,121	1,824	2,266	1,971	2,075	2,014	2,266	2,321	2,024	2,435	2,170	2,287	2,244
2001	2,103	2,152	1,905	2,305	1,965	2,128	2,080	2,324	2,361	2,162	2,466	2,209	2,351	2,317
2002	2,114	2,171	1,884	2,330	1,979	2,120	2,127	2,320	2,379	2,068	2,516	2,209	2,317	2,350
2003	2,137	2,177	1,941	2,288	1,998	2,142	2,166	2,330	2,382	2,113	2,443	2,198	2,335	2,387
2004	2,140	2,207	1,933	2,361	1,993	2,164	2,149	2,349	2,402	2,122	2,543	2,222	2,368	2,352
2005	2,227	2,273	1,952	2,339	2,054	2,259	2,236	2,434	2,479	2,137	2,556	2,310	2,463	2,434
2006	2,248	2,305	1,909	2,395	2,035	2,286	2,275	2,469	2,519	2,120	2,612	2,290	2,499	2,488
2007	2,277	2,319	1,956	2,281	2,064	2,325	2,286	2,521	2,581	2,133	2,550	2,328	2,573	2,524
2008	2,215	2,270	1,963	2,312	2,019	2,266	2,216	2,519	2,582	2,203	2,651	2,331	2,564	2,508
2009	2,135	2,185	1,909	2,211	1,931	2,198	2,140	2,438	2,490	2,156	2,594	2,216	2,488	2,434
2010	2,169	2,203	1,877	2,336	2,001	2,184	2,143	2,392	2,443	2,091	2,613	2,265	2,393	2,386
RSE	2	2	4	6	3	4	3	2	2	4	6	2	3	4

A. Represents an RSE that is greater than or equal to 100 or could not be computed.  
 NA. Not available. RSE. Relative Standard Error.  
 S. Withheld because estimate did not meet publication standards on the basis of response rate, associated standard error, or a consistency review.

<sup>1</sup>Includes houses built for rent (not shown separately).

## Appendices 9

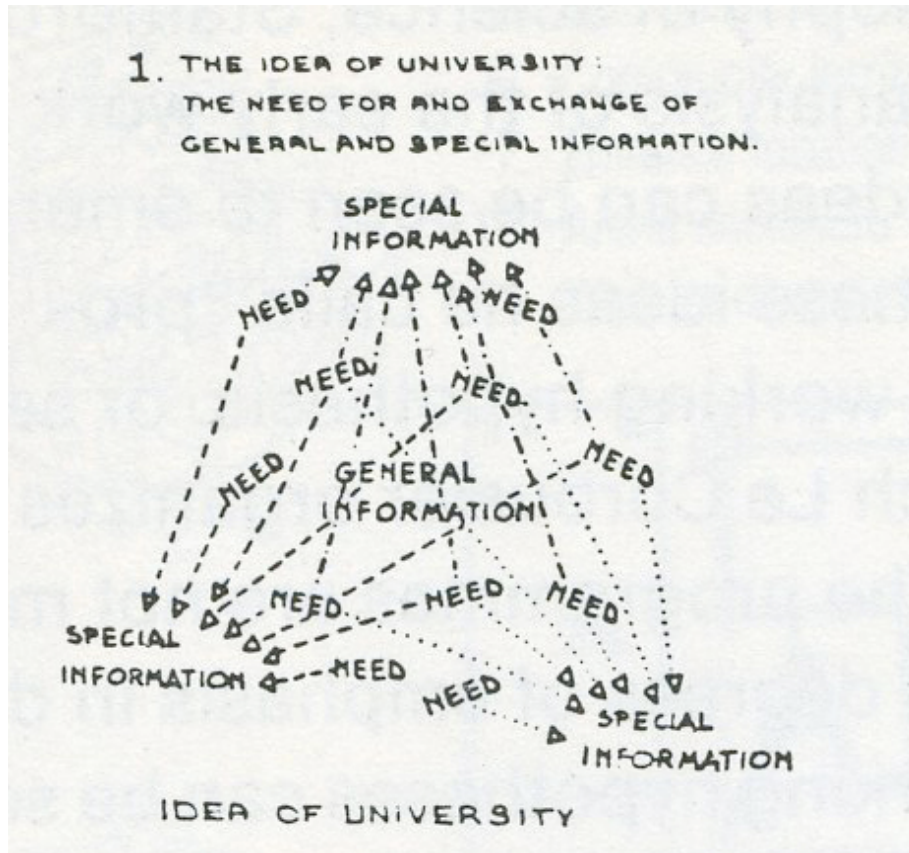
Figure 9, Generational Difference Chart (Gaylor, D, 2002)

<b>Generational Differences Chart</b>				
	<b>Traditionalists</b>	<b>Baby Boomers</b>	<b>Generation X</b>	<b>Millennials</b>
<b>Birth Years</b>	1900-1945	1946-1964	1965-1980	(1977-1994) 1981-2000
<b>Current Age</b>	63-86	44-62	28-43	8-27
<b>Famous People</b>	Bob Dole, Elizabeth Taylor	Bill Clinton, Meryl Streep	Barack Obama, Jennifer Lopez	Ashton Kutcher, Serena Williams
<b>#</b>		80 Million	51 Million	75 Million
<b>Other Names</b>	Veterans, Silent, Moral Authority, Radio Babies, The Forgotten Generation	"Me" Generation, Moral Authority	Gen X, Xers, The Doer, Post Boomers, 13 <sup>e</sup> Generation	Generation Y, Gen Y, Generation Next, Echo Boomers, Chief Friendship Officers, 24/7's
<b>Influencers</b>	WWII, Korean War, Great Depression, New Deal, Rise on Corporations, Space Age,  Raised by parents that just survived the Great Depression.  Experienced hard times while growing up which were followed by times of prosperity.	Civil Rights, Vietnam War, Sexual Revolution, Cold War/Russia, Space Travel  Highest divorce rate and 2 <sup>nd</sup> marriages in history.  Post War Babies who grew up to be radicals of the 70's and yuppies of the 80's.  "The American Dream" was promised to them as children and they pursue it. As a result they are seen as being greedy, materialistic and ambitious.	Watergate, Energy Crisis, Dual Income families and single parents, First Generation ofLatchkey Kids, Y2K, Energy Crisis, Activism, Corp. Downsizing, End of Cold War, Mom's work, Increase divorce rate.  Their perceptions are shaped by growing up having to take care of themselves early and watching their politicians lie and their parents get laid off.  Came of age when USA was losing its status as the most powerful and prosperous nation in the world.  The first generation that will NOT do as well financially as their parents did.	Digital Media, child focused world, school shootings, terrorist attacks, AIDS, 9/11 terrorist attacks.  Typically grew up as children of divorce They hope to be the next great generation & to turn around all the "wrong" they see in the world today. They grew up more sheltered than any other generation as parents strived to protect them from the evils of the world. Came of age in a period of economic expansion. Kept busy as kids First generation of children with schedules.



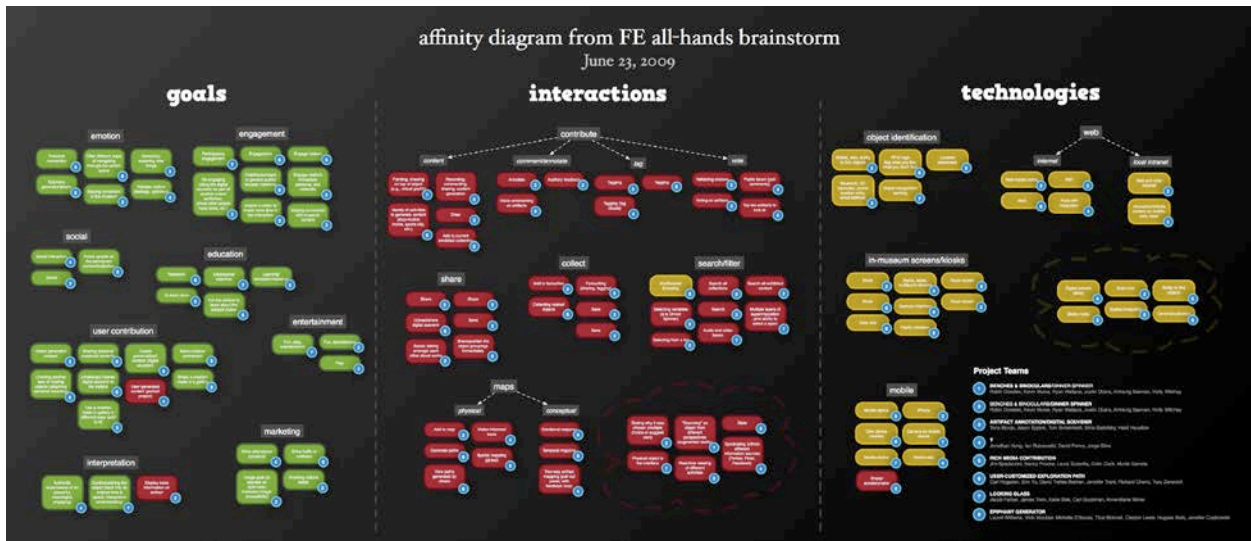
## Appendices 10

Figure 10, Heuristics for the Berlin Free University (Rowe, P., 1987)



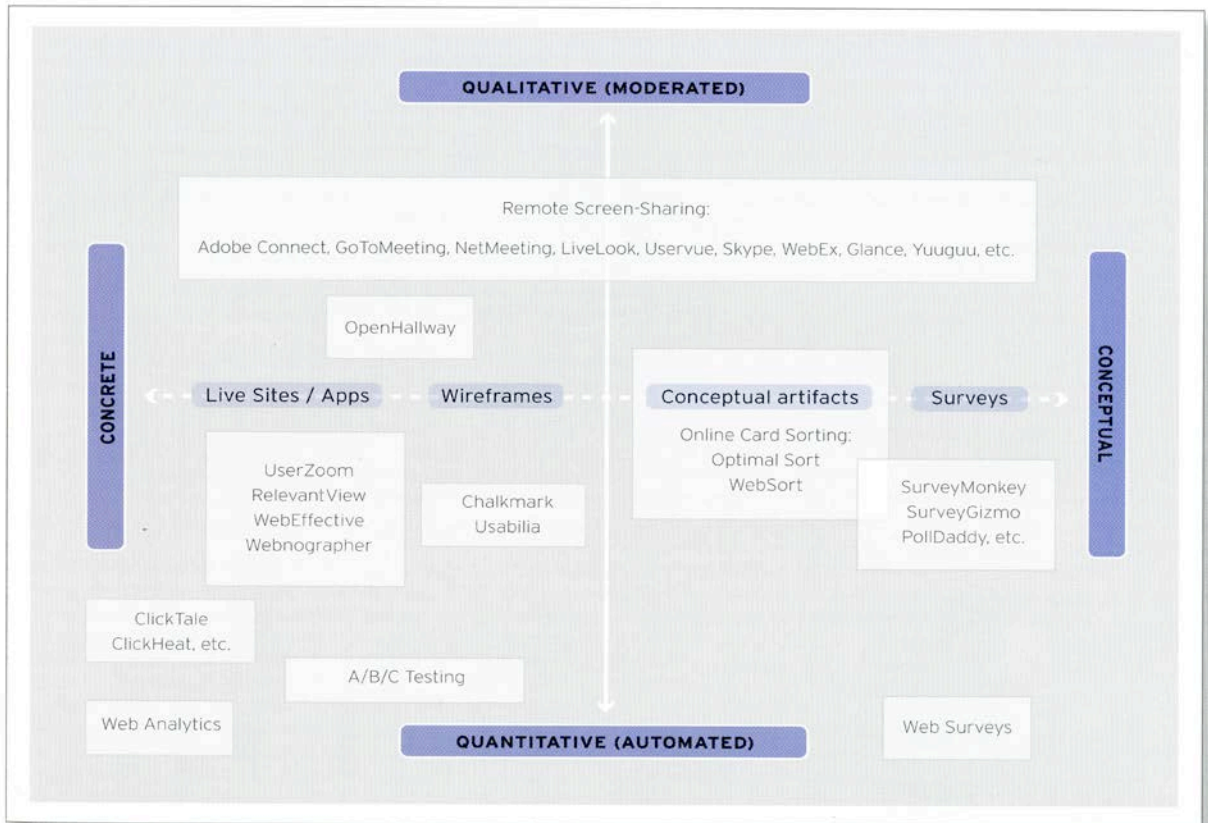
# Appendices 11

Figure 11, Affinity Diagram from FE all-Hands Brainstorm (Yoon, j, 2009)



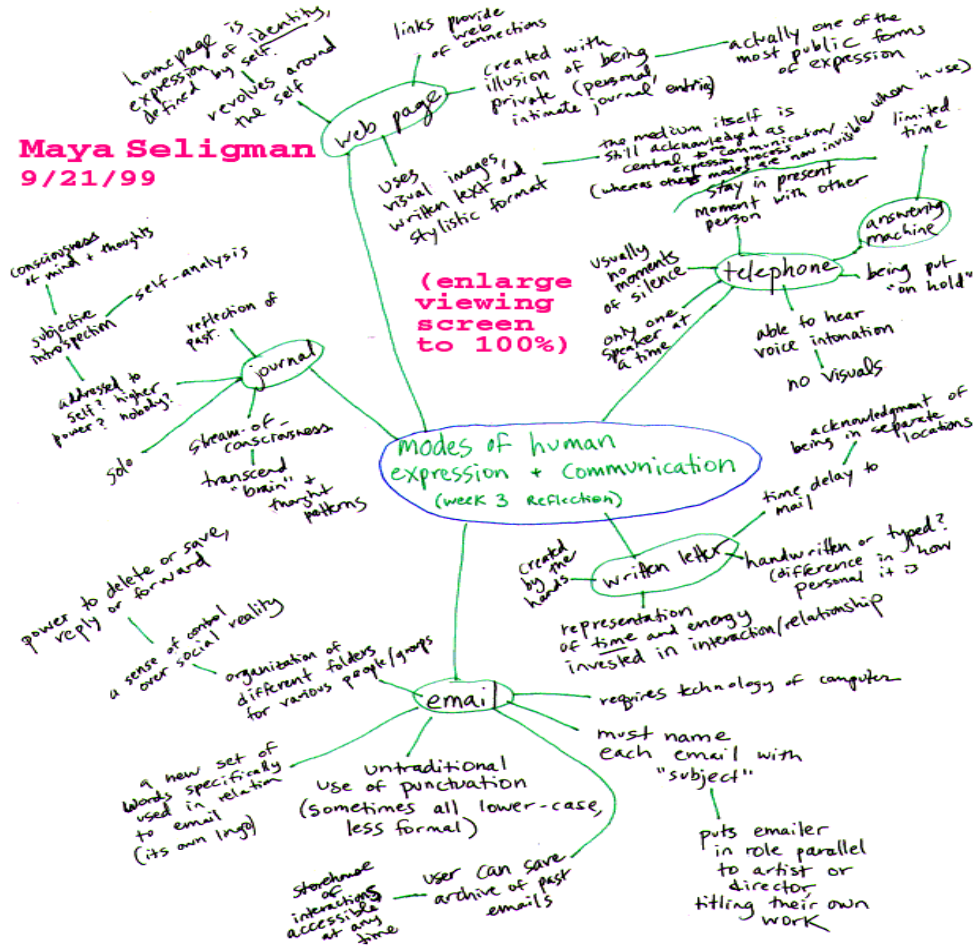
## Appendices 12

Figure 12, Automated Remote Research Form (Martin, B., & Hanington, B. M. 2012)



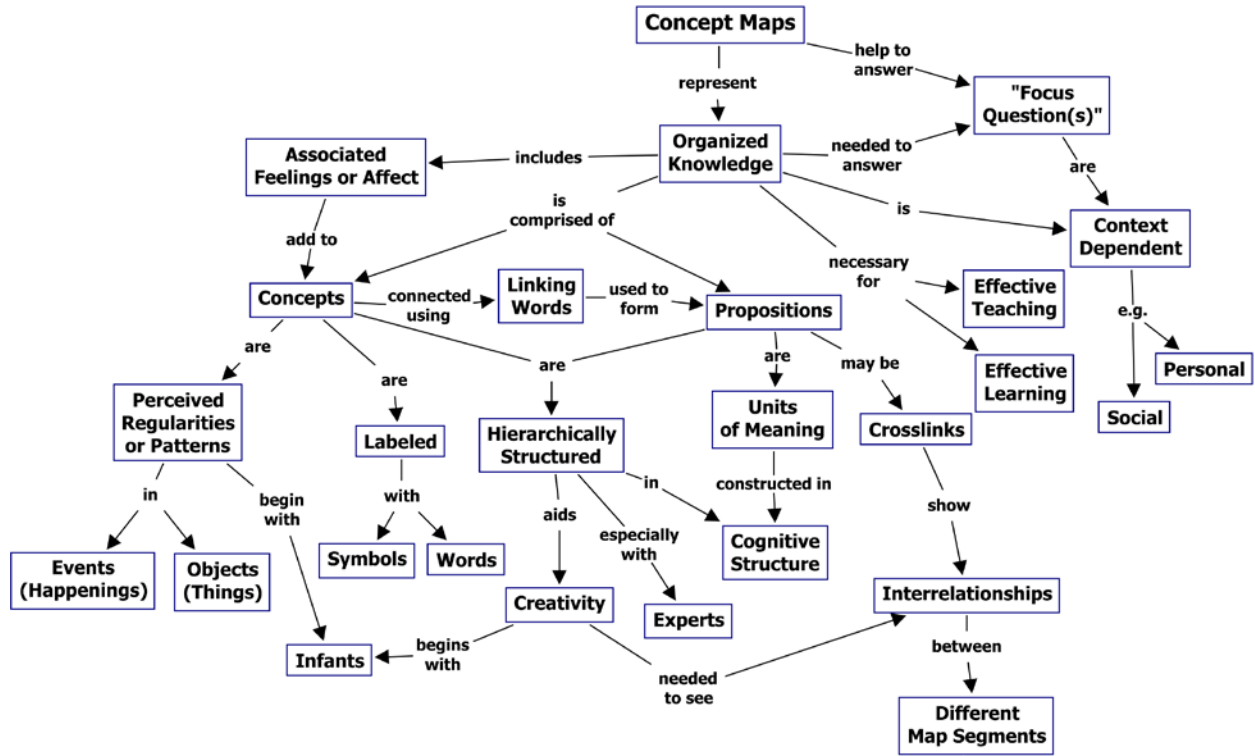
# Appendices 13

Figure 13, Example of Brainstorm Graphic Organizers (Martin, B., & Hanington, B. M. 2012)



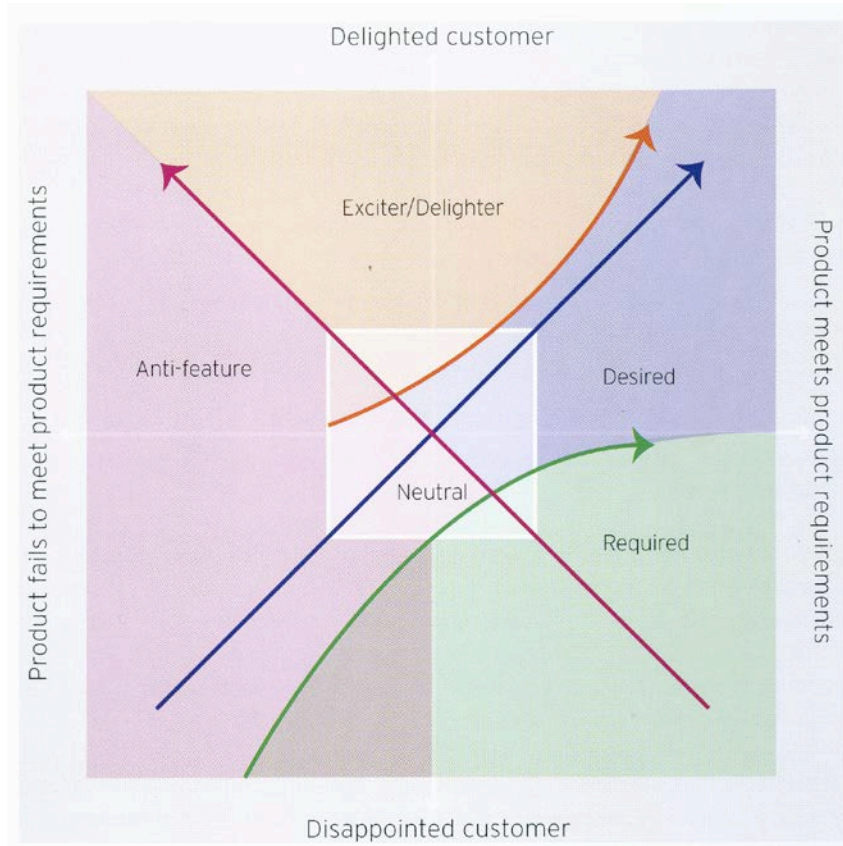
## Appendices 14

Figure 14, Concept mapping (Novak, J & Canas, A, 2010)



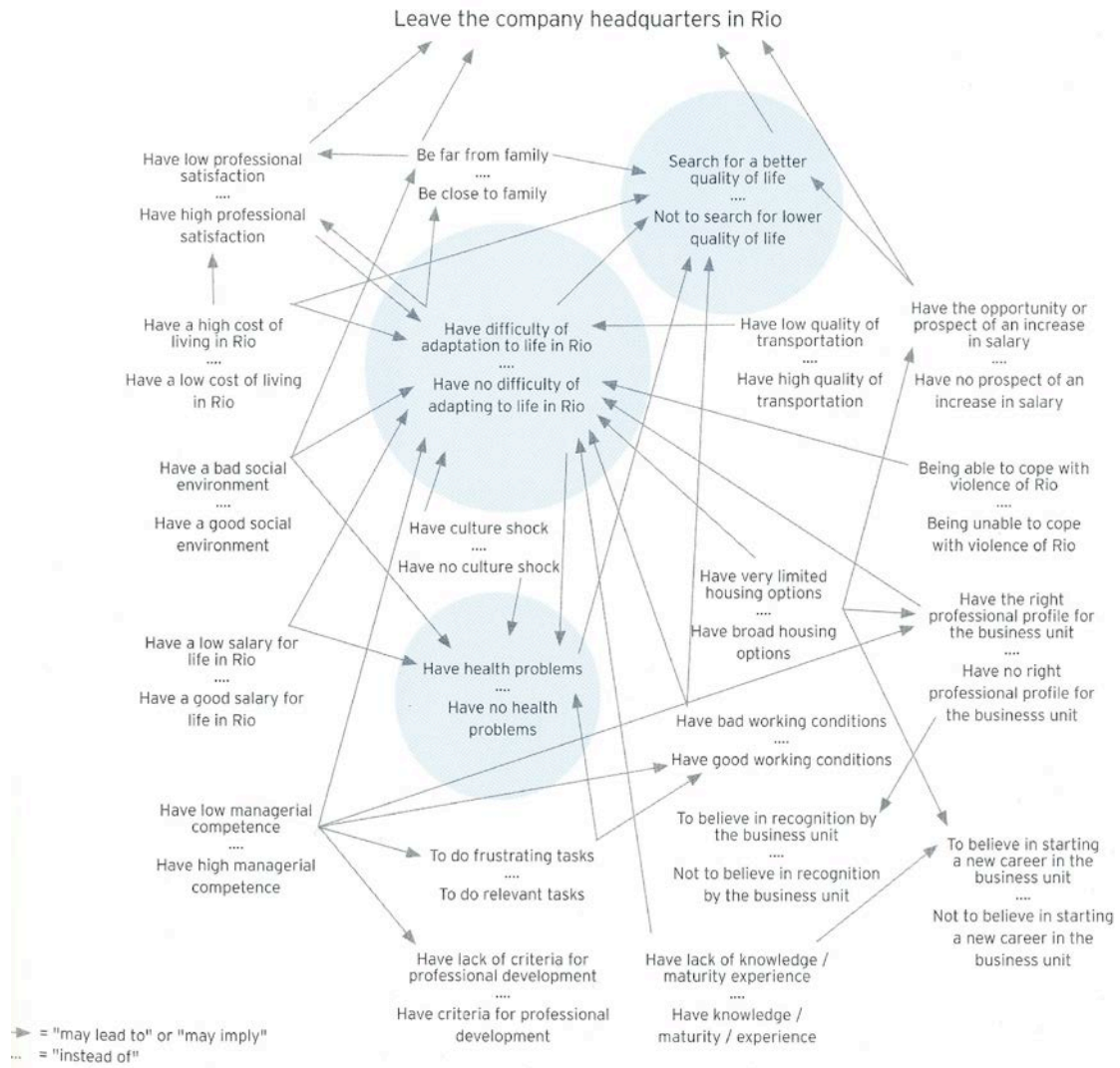
## Appendices 15

Figure 15, Kano analysis (Martin, B., & Hanington, B. M. 2012)



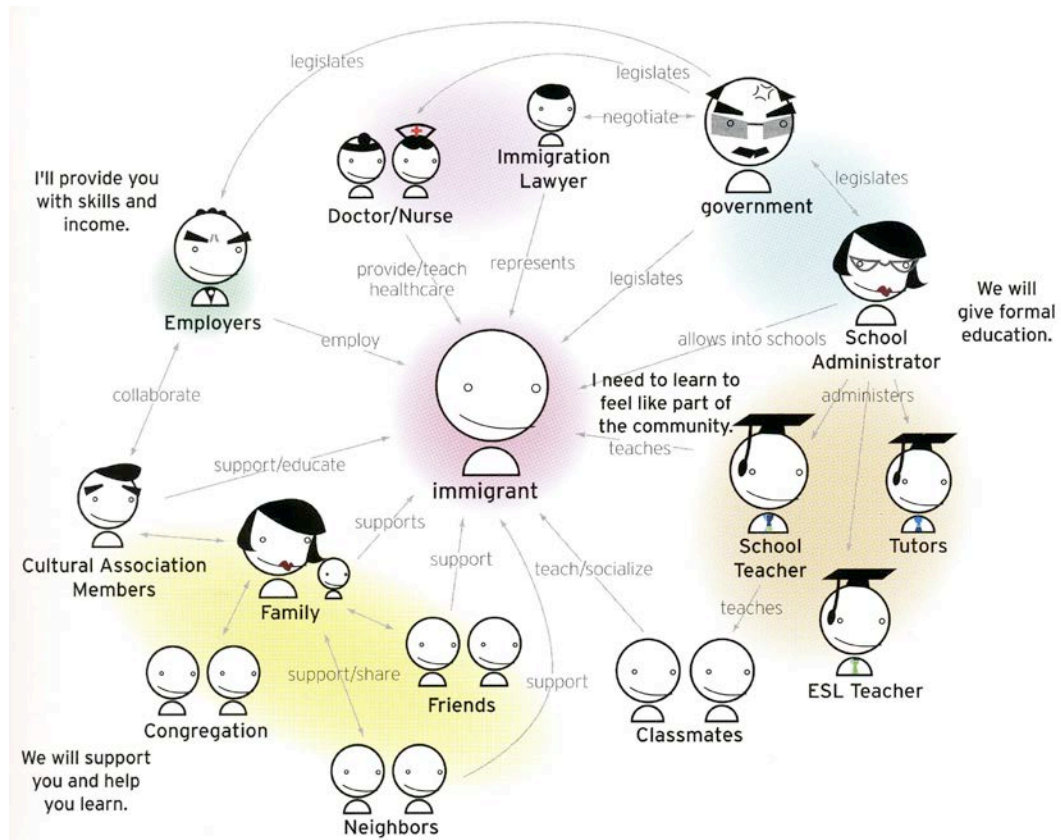
## Appendices 16

Figure 16, Cognitive mapping (Martin, B., & Hanington, B. M. 2012)



## Appendices 17

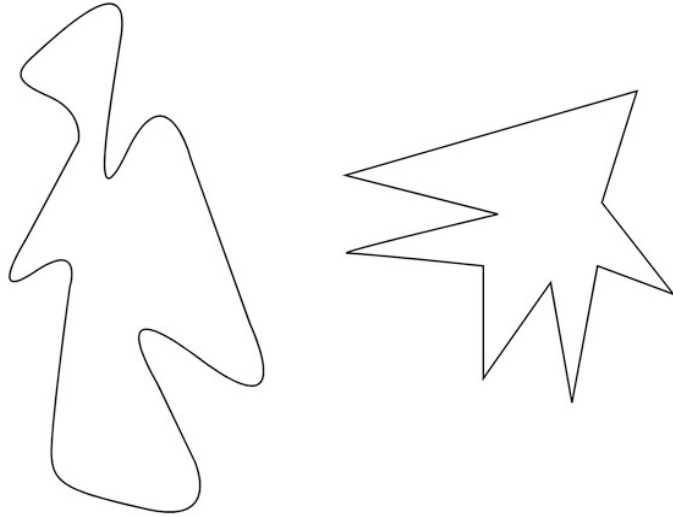
Figure 17. Stakeholder Maps (Martin, B., & Hanington, B. M. 2012)





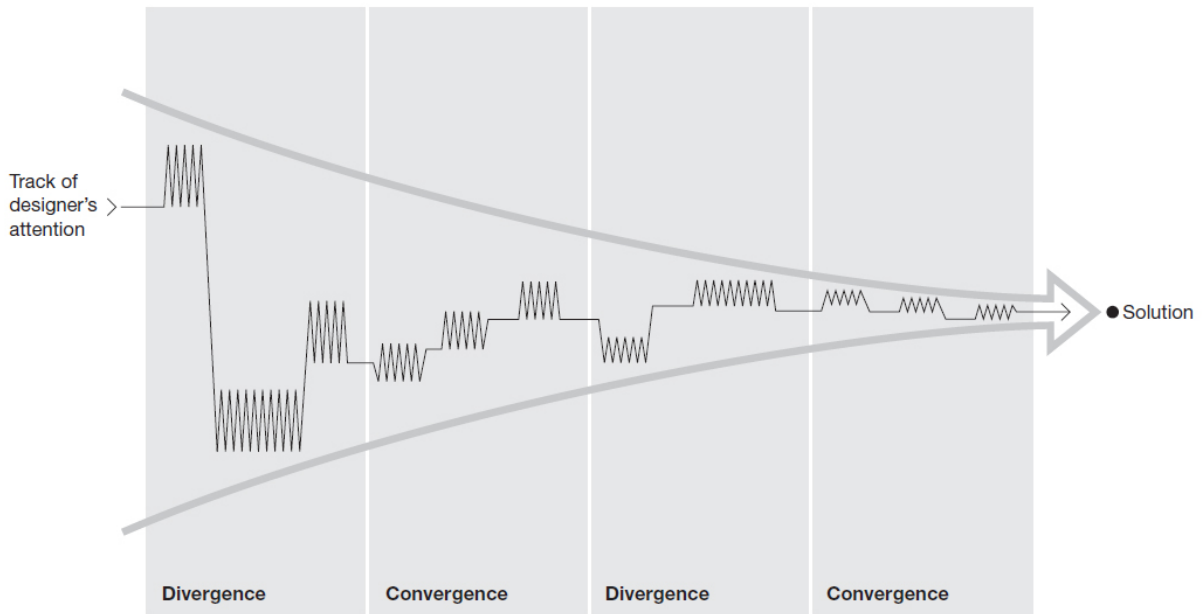
## Appendices 18

Figure 18. "Bouba" & "Kiki" (Ramachandran, S.,2011)



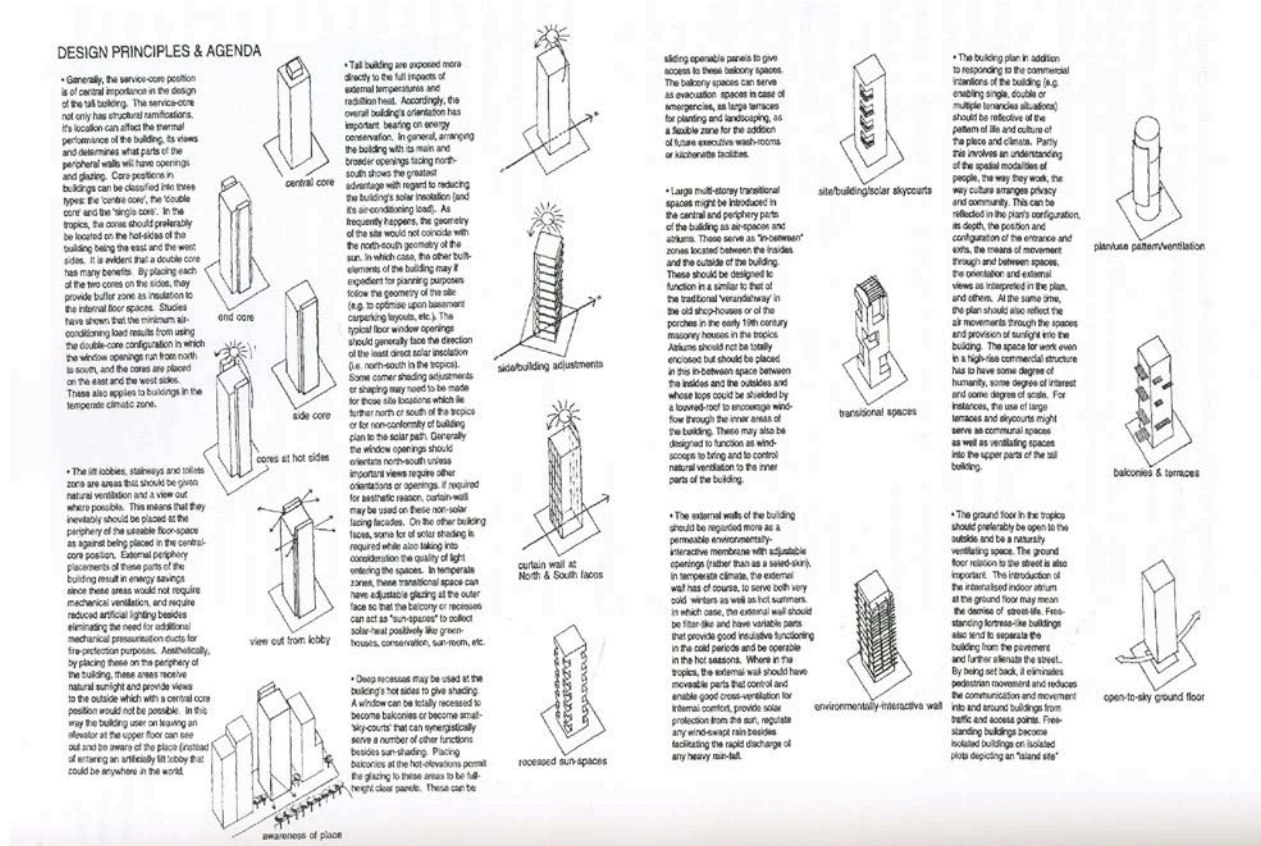
## Appendices 19

Figure 19, Cross's design process must converge (Dubberly, H., 2005)



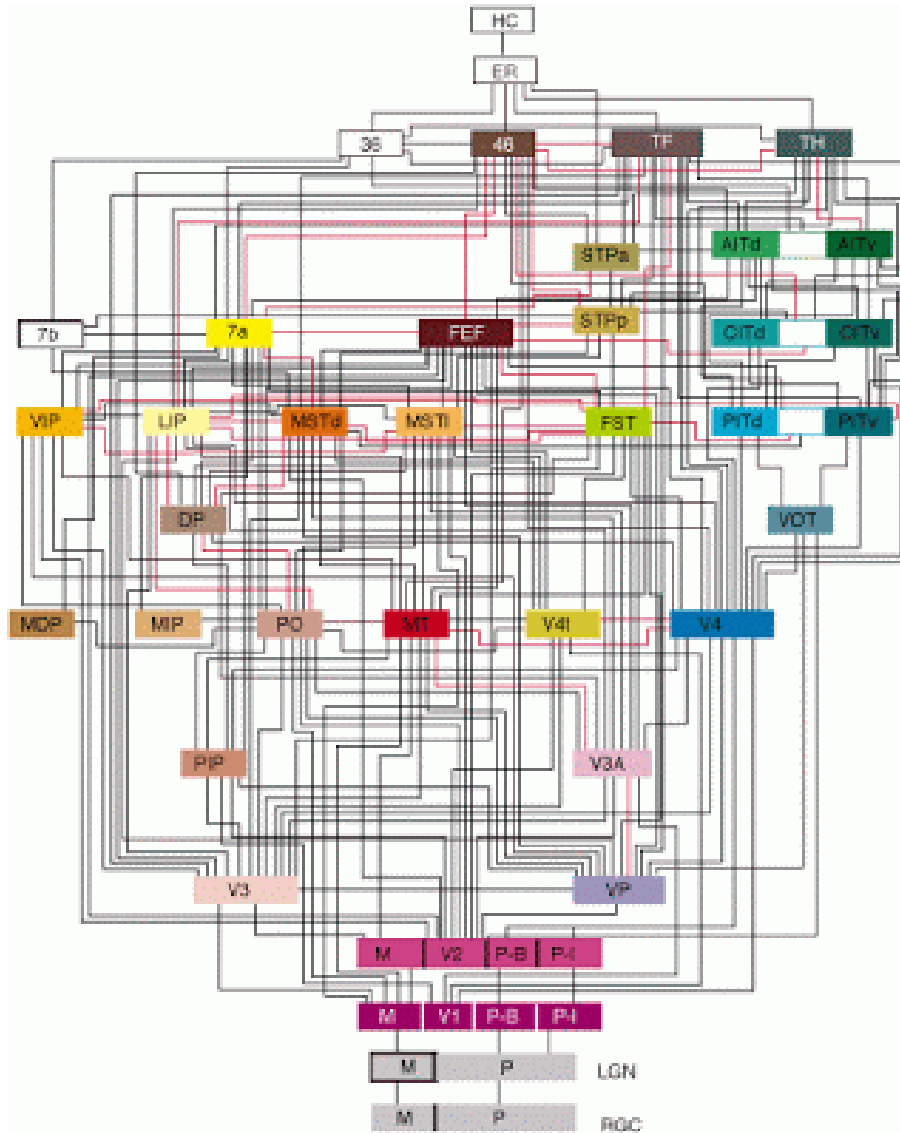
## Appendices 20

Figure 20, some of Ken Yeang's principles for designing the ecologically sound tropical skyscraper (Yeang, k., 1996)



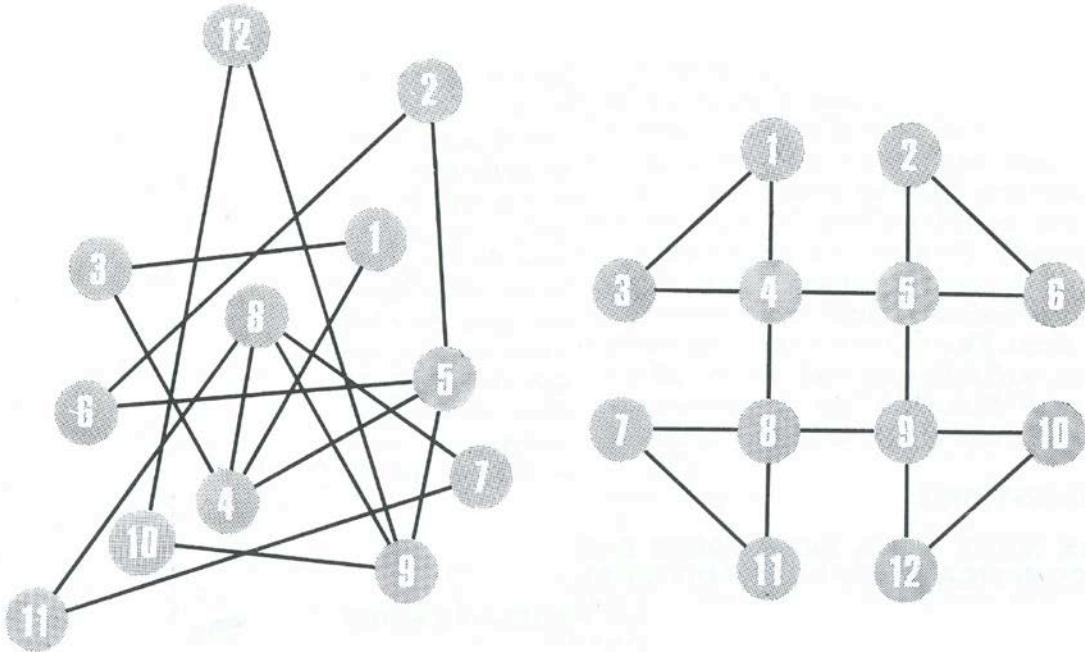
## Appendices 21

Figure 21, Hierarchy of visual areas (Ramachandran, S.,2011)



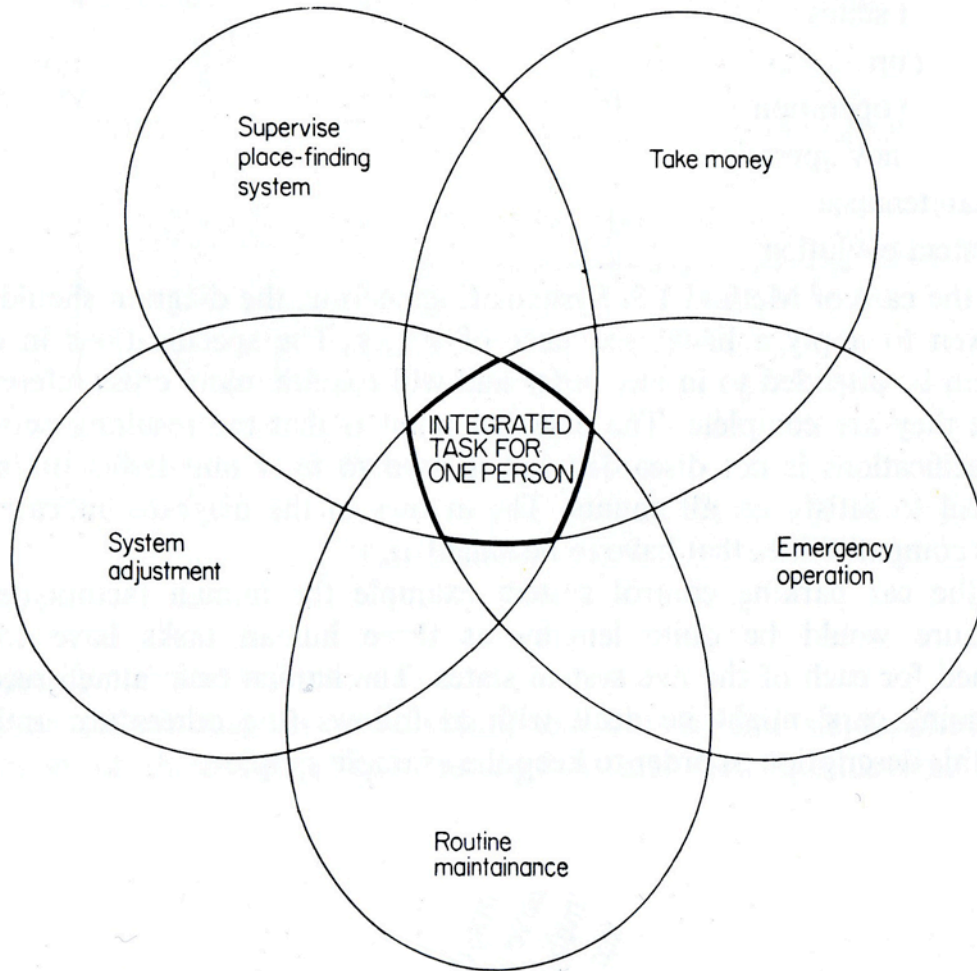
## Appendices 22

Figure 22, (Jones, J. C., 1992)



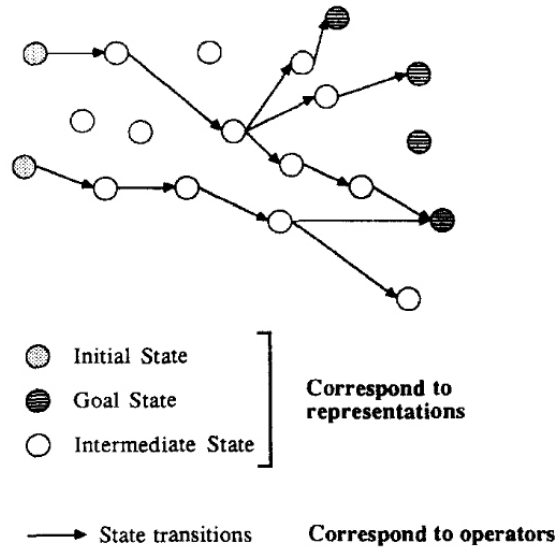
## Appendices 23

Figure 23, (Jones, J. C., 1992)



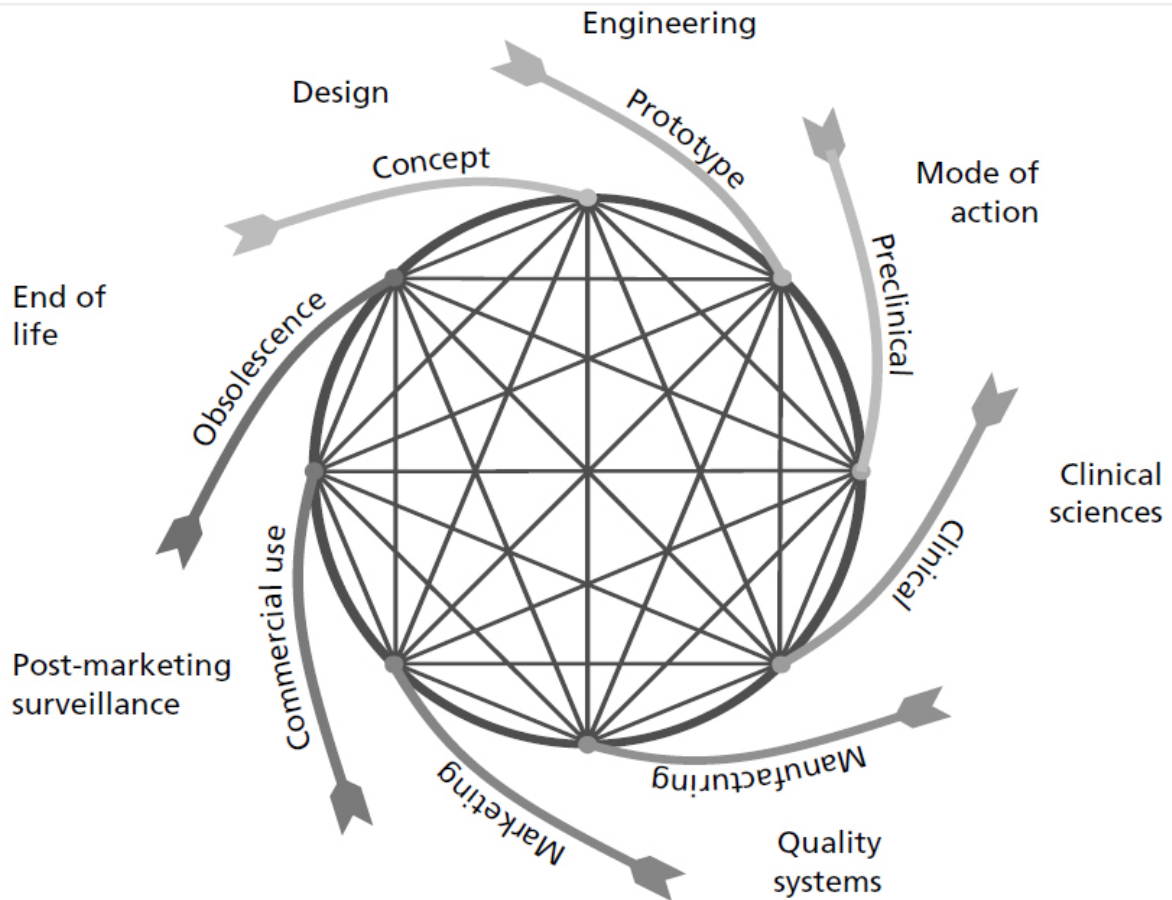
## Appendices 24

Figure 24, A generic diagram for search (Woodbury, 1991)



## Appendices 25

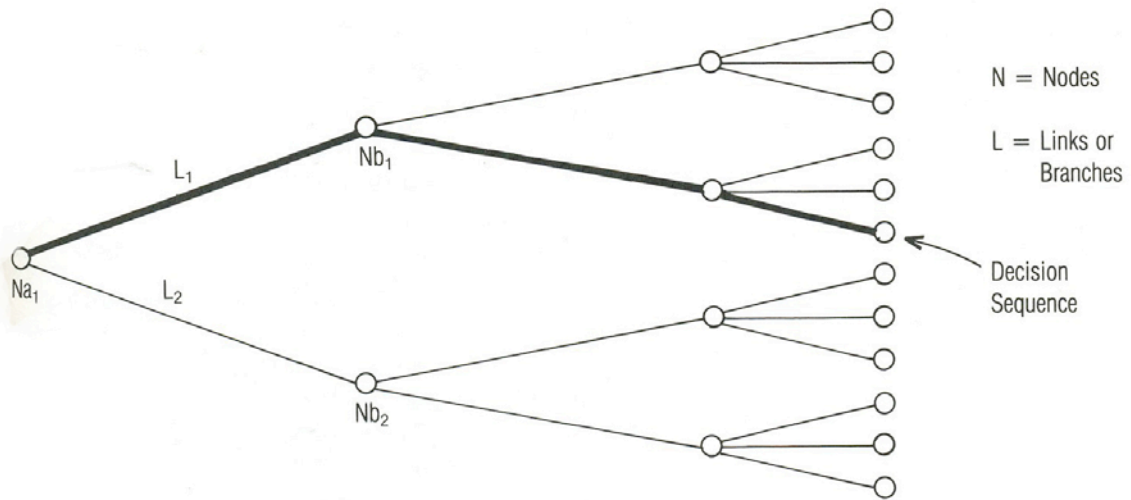
Figure 25, the total product life-cycle model for medical device design (Clarkson, J., & Eckert, C., 2005)





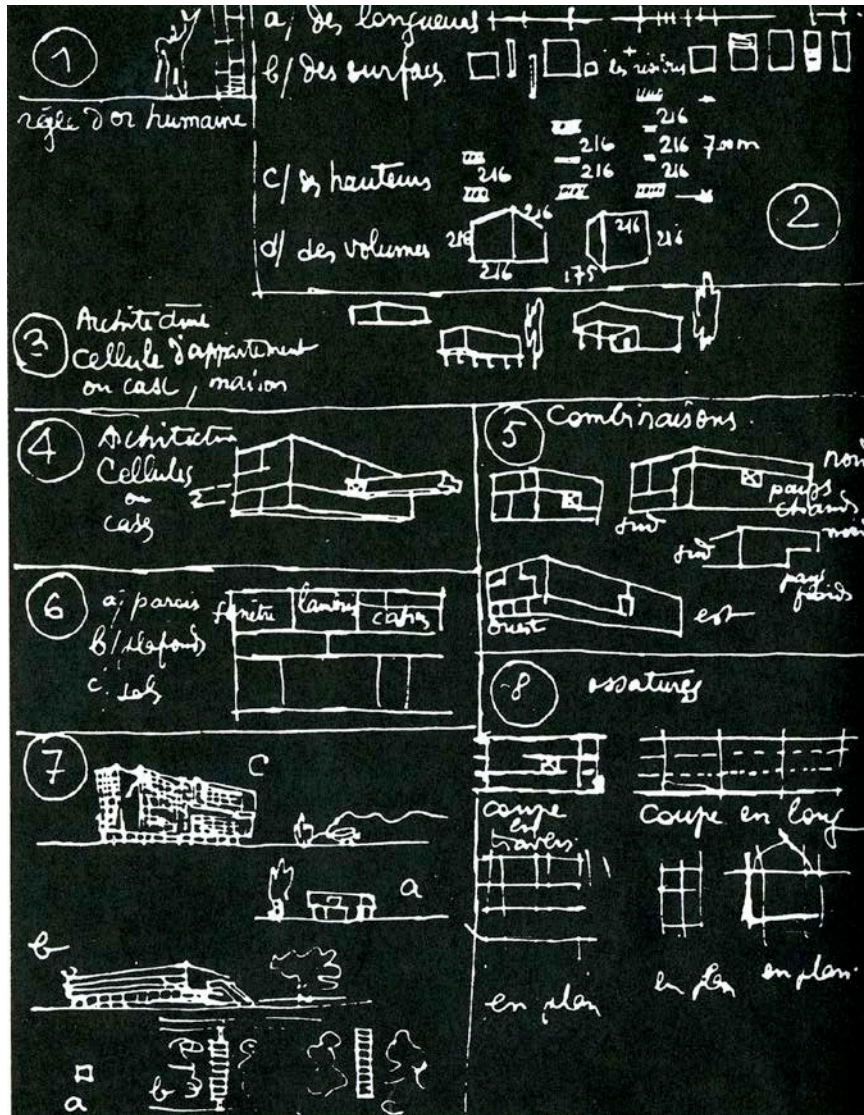
## Appendices 26

Figure 26, A General Diagram of Decision Tree (Rowe, P., 1987)



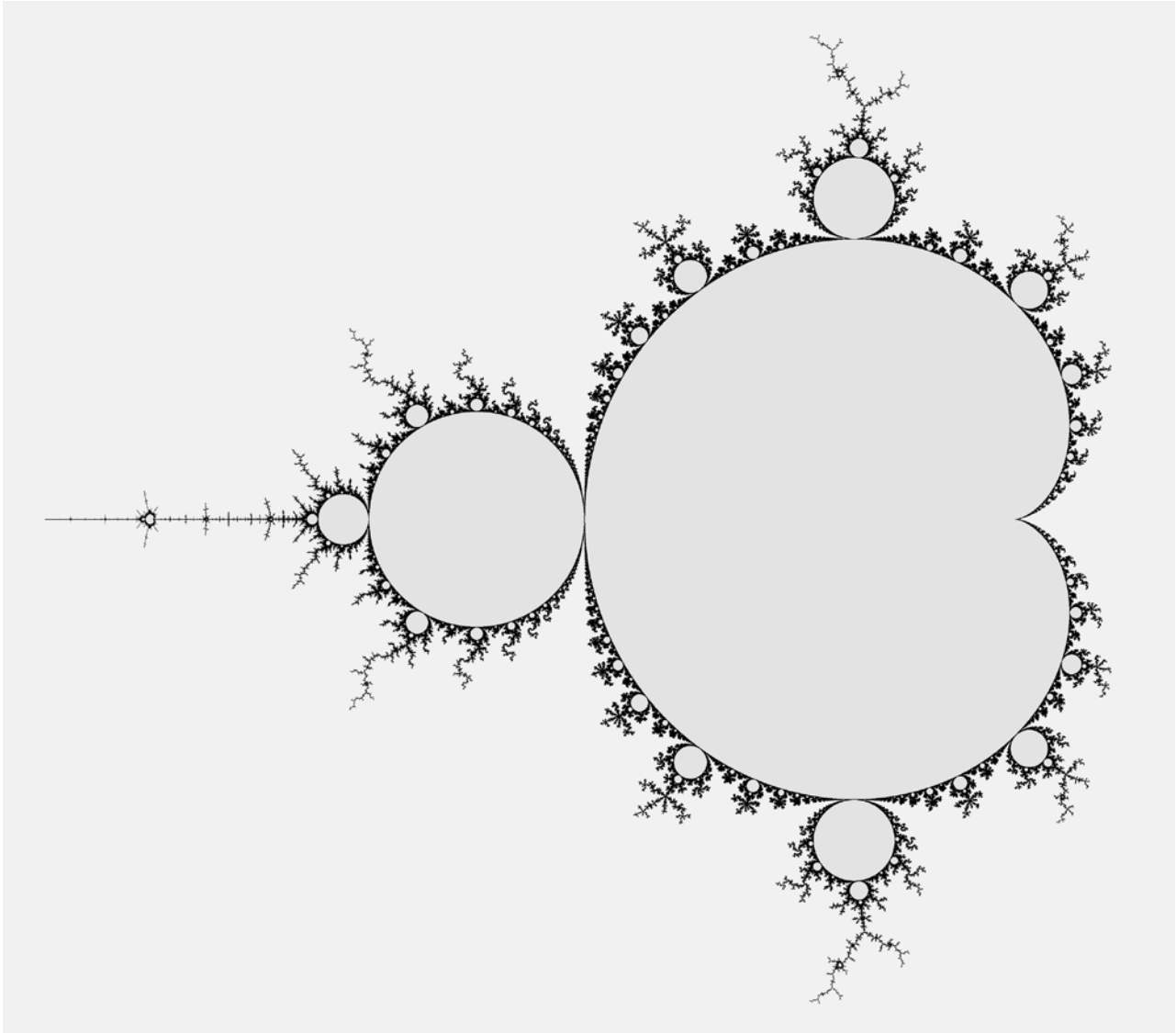
## Appendices 27

Figure 27, Le Corbusier's guidelines for the ATBAT project (Rowe, P., 1987)



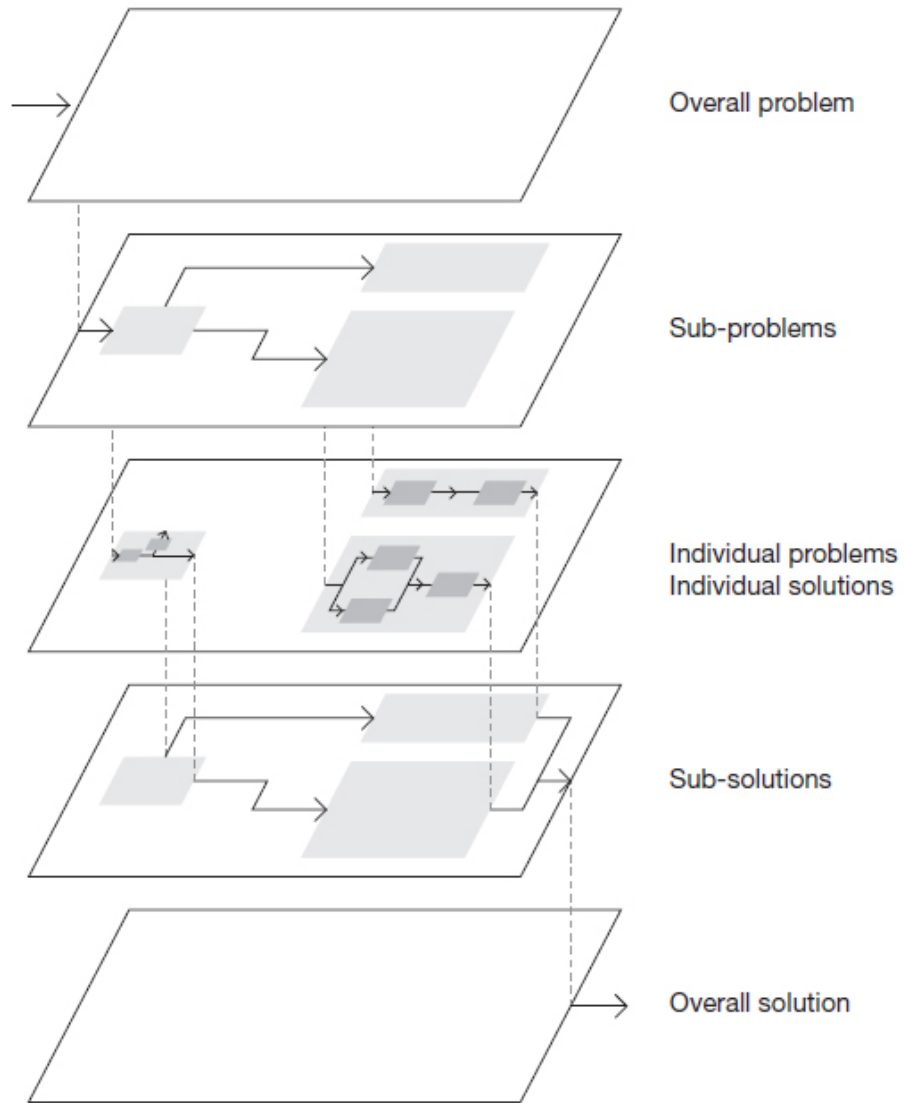
## Appendices 28

Figure 28, Mandelbrot set (Tan, L, 2000)



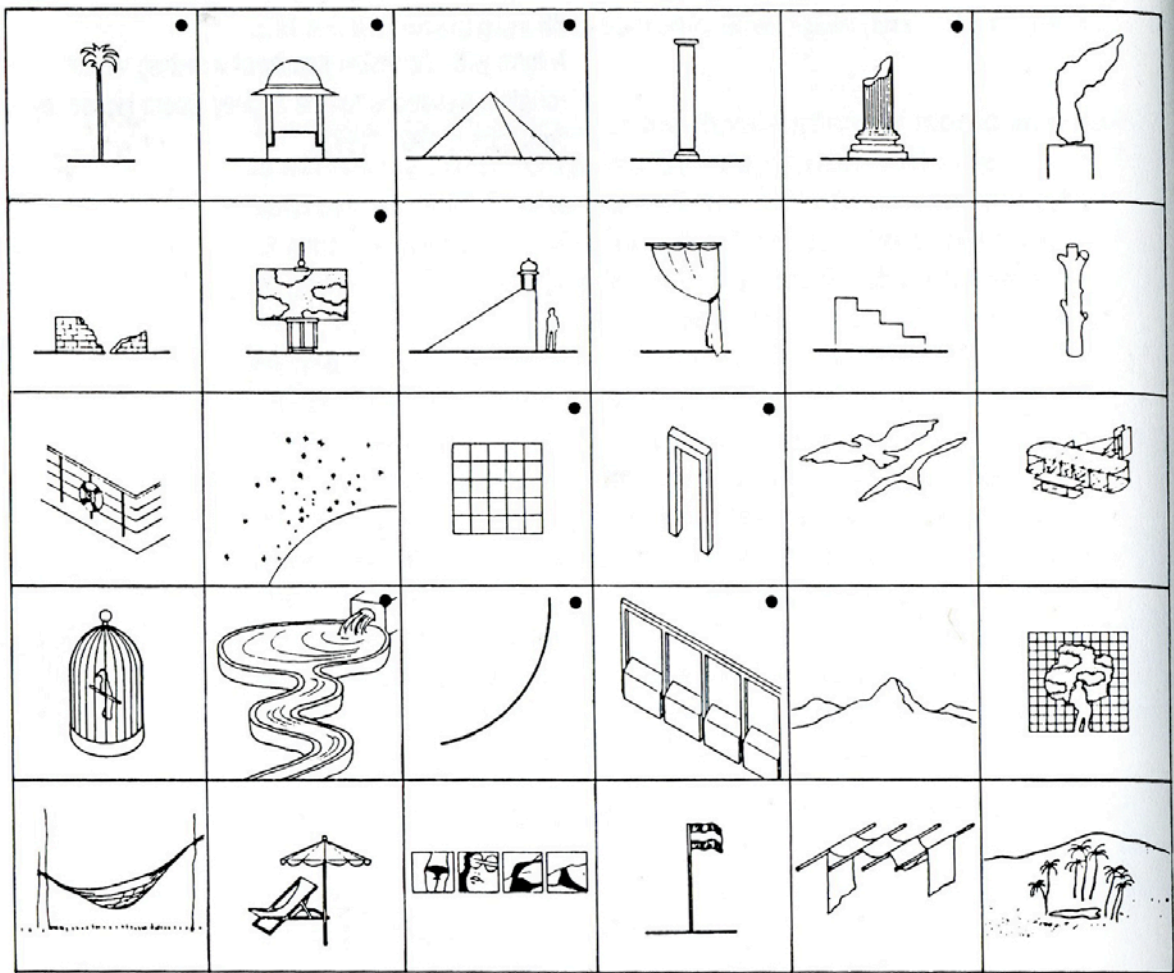
## Appendices 29

Figure 29, Decomposition - recombination system (Dubberly, H., 2005)



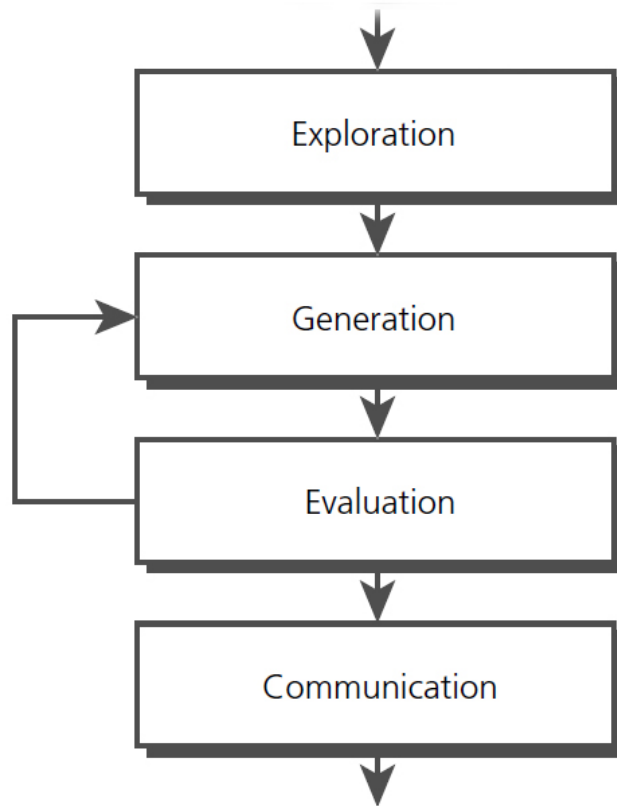
### Appendices 30

Figure 30, Elements of a narrative scenario (Rowe, P., 1987)



## Appendices 31

Figure 31, Cross's model of design (Cross, 1994)



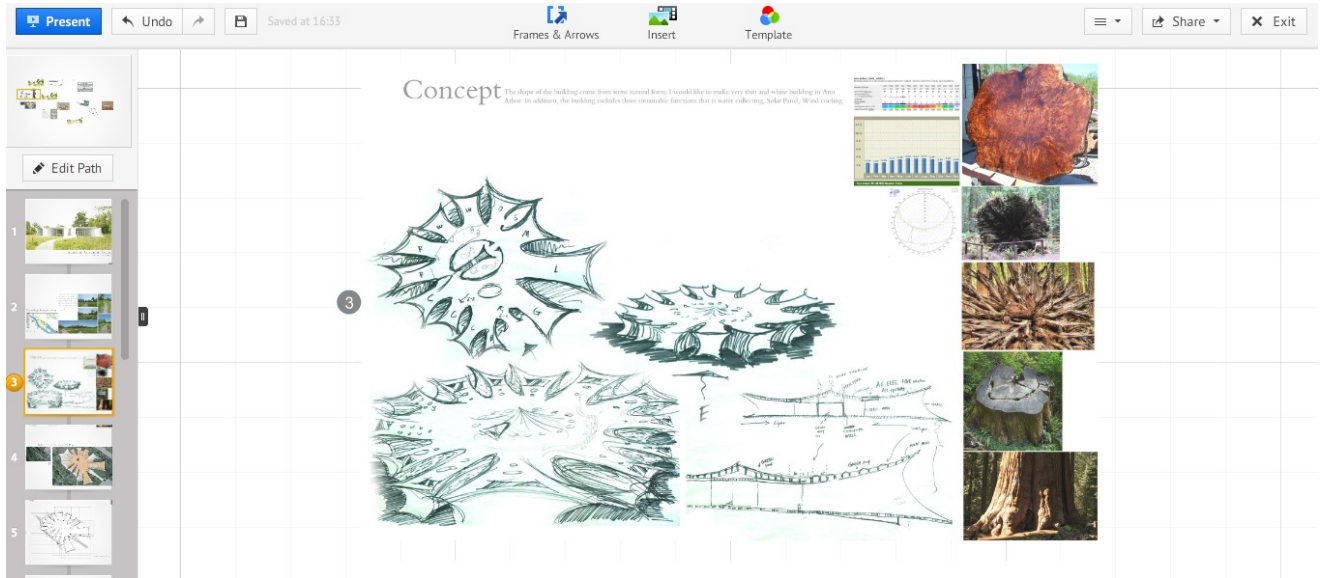
## Appendices 32

Figure 32, Prezi canvas' characteristic example (Prezi Inc. n.d.)



## Appendices 33

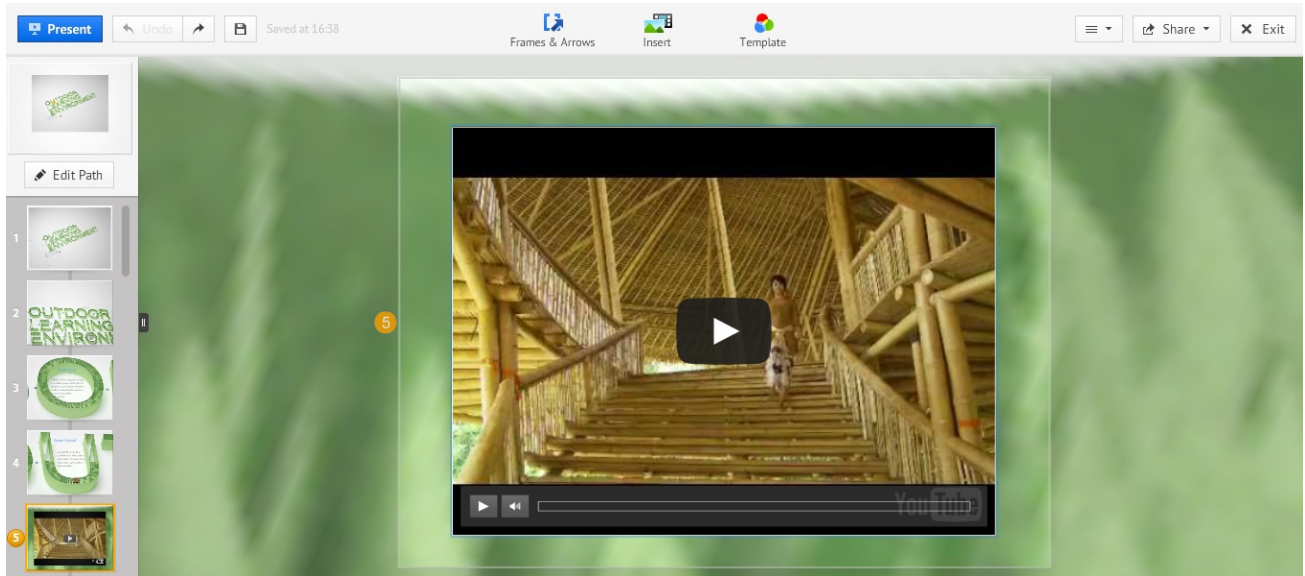
Figure 33, Prezi canvas shows pictures and text





## Appendices 34

Figure 34, Prezi canvas shows video



## Appendices 35

Figure 35, Stage in Prezi canvas



## Appendices 36

Figure 36. Sponsor's instructions & signers' predictions of the outputs from each stage of the process (Jones, J. C., 1992)

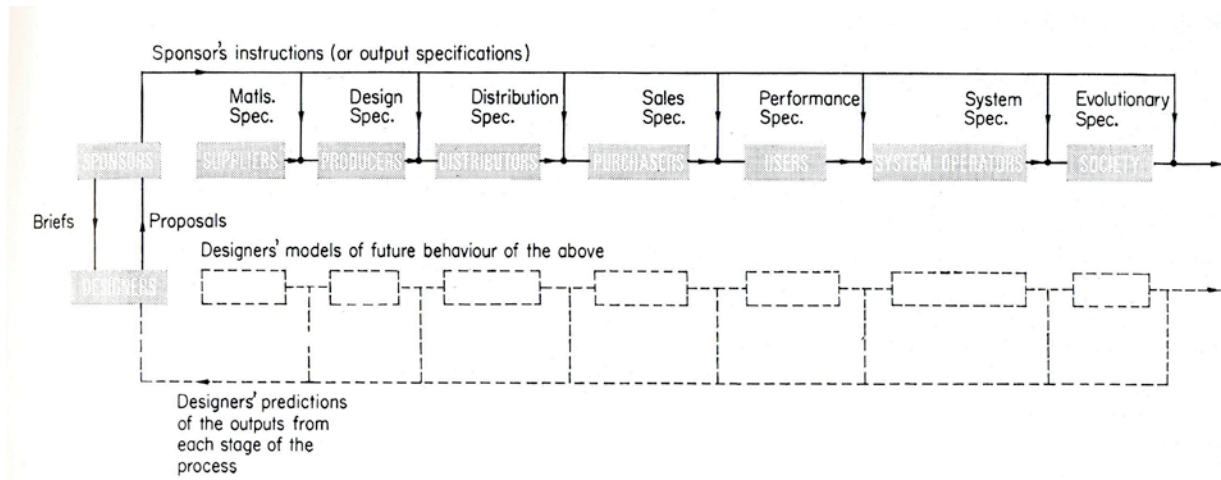


Fig. 1.1