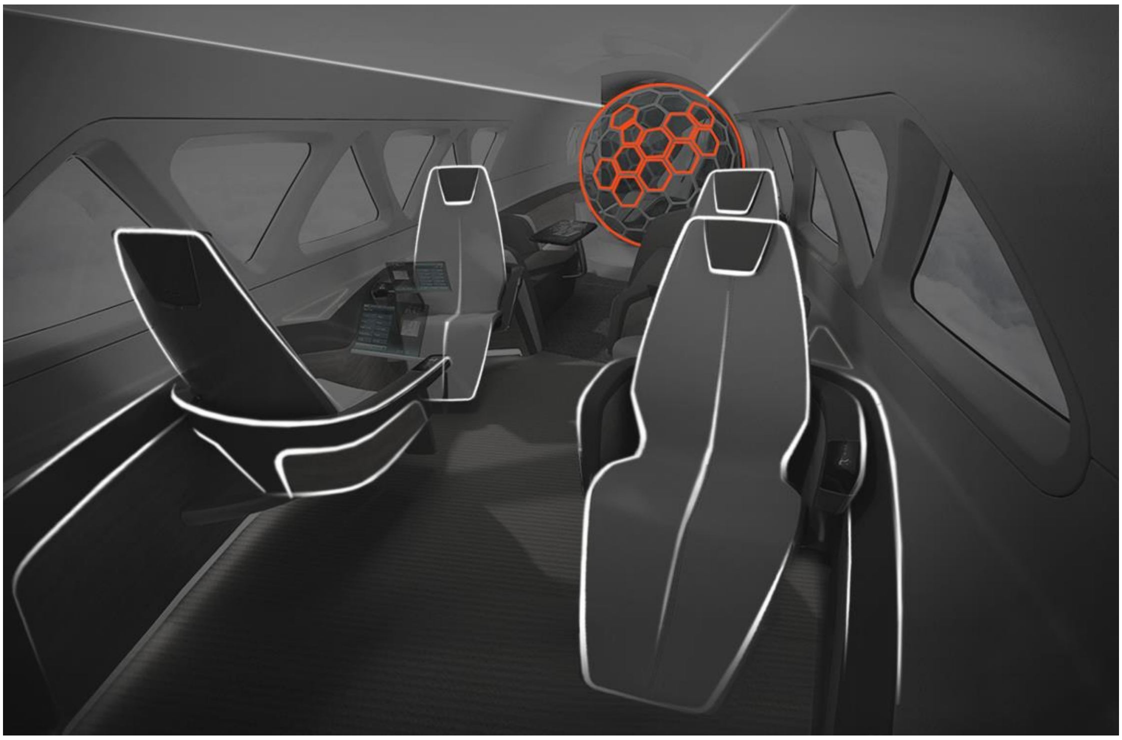
The Form Language of Almadesign

A study on Context, Syntax and Semantics



VOLUME I

Ramo de Doutoramento:
Design
Doutorando:
André Galhardo Lopes de Castro
Orientadores:
Doutora Rita Assoreira Almendra
Doutor José Rui Marcelino

Ano 2018
Tese especialmente elaborada para a obtenção do grau de doutor

FACULDADE DE ARQUITETURA
UNIVERSIDADE DE LISBOA

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cover image: Form Syntax in project “LIFE” (source: researcher, 2017)

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ABSTRACT

Industrial Design is an activity which employs different methodologies, from social science to art principles, from engineering processes to management practices. Being influenced by car design and aircraft design since its inception, Almadesign studio professionals are skilled in the industrial design profession with a specific “technical approach”. The combination of design thinking methodologies with the technical side of transport design, has led to the focus on this investigation, which is the Form Language development in design, defined as the most important task of the industrial designer, where all the different activities are conceptualized in solutions. The definition of the product form, an activity situated between analyzing information and transforming it into a product, is considered a fundamental task of the industrial designer, best stated by American aircraft designer, Daniel Raymer:

> *“(Aircraft) design is a separate discipline of aeronautical engineering – different from the analytical disciplines such as aerodynamics, structures, controls and propulsion. An aircraft designer needs to be well versed in these and many other specialties, but will actually spend little time performing such analysis (…) Instead, the designer’s time is spent doing something called “design”, creating the geometric description of a thing to be built.” (Raymer, 1994, p.2)*

An industrial designer is more than just the creator of the geometric description of the thing to be built, as he should be versed in social sciences when he researches the market and observes users; should to be able to sketch and illustrate ideas and visions; to materialize sketches into mathematical models using 3D CAD software; to engineer different parts into completed prototypes; to be a manager of both people and resources. Designers should indeed be able to solve all kinds of problems using design thinking methodologies which start from a blank page and, hopefully, turn out as useful solutions available in the market. The Form Language development chosen as the central focal point of this investigation defined as the geometric description of the products to be build including its colour, material and finish.

The investigation focuses on the work developed in Portuguese design studio Almadesign, founded by Rui Marcelino in 1997, and where the researcher has been working for the past 16 years. The studio has been developing transport, product and interior design projects - over 600 – in two decades of activity in Portugal. The development of a specific Form Language is a complex, organic and evolving process, as is the creation of meaning through a design product and its context of use. By investigating the Form Language developed at Almadesign studio, it is expected that a model of analysis can be developed, which can be applied to other studios and design practices. Hence, the researcher hopes to contribute to the body of design theory and hopefully, help bring Market practices and Academia closer, by proposing a Model for the development of a Form Language: the process by which the professional designers use design elements and principles to create symbolic meaning through products.

The main investigation question is whether it is possible to define a specific Form Language developed in the studio and, if so, if it is possible to identify it and characterize it. To answer this question, 3 investigation vectors were developed which help define the specific objectives of the investigation:

- **Context:** analyzing the context of the studio in two decades of activity, in the perspective of internal (designers, methodologies, processes) and external contexts (social, economic and technological changes, design history);
- **Form syntax:** characterizing the studio's Design Elements and its organization through Design Principles;
- **Form semantics:** characterizing the studio's creation of Symbolic Meaning through product design and its interpretation by clients / partners;

It is considered that the point of view of the investigation was intrinsically biased, as the researcher has been working at Almadesign for the past 16 years. Parallel to this activity, the researcher has been teaching as a design teacher at the Faculty of Architecture in Lisbon for the last 10 years. This context allows the researcher to have a specific point of view from both the Market and the Academia perspectives, which can eventually help in bridging the gap between these two entities, enabling the knowledge transfer considered essential to developing new ideas, products and processes. The researcher employed a series of different methodologies, both empirical and theoretical, in order to tackle the challenge of identifying and characterizing the Form Language of the studio: Literature Review on the three investigation vectors; Experimental Studies with both students and studio's professional designers; Case Studies with clients / partners, based on studio's projects. These methodologies were developed through a period of about two and a half years, and the data gathered, conclusions and Form Language Model are some of the results of this investigation.

Further research will be needed to develop a deeper knowledge on this subject, nevertheless, it is considered that the investigation was able to identify and characterize the most important features of the Form Language development at Almadesign.

KEYWORDS

Form Language, Form Syntax, Form Semantics, Design Studio, Almadesign

RESUMO

O design industrial é uma actividade que agrega diferentes metodologias, que combinam as Ciências Sociais, os Princípios da arte, processos de Engenharia e as práticas da Gestão. Sendo influenciado pelo design de automóveis e pelo design de aeronaves desde a sua criação, o estúdio tem vindo a especializar-se em serviços de design industrial com uma componente técnica acentuada (i.e. design de meios de transporte) pelo que, no contexto desta investigação, se considerou fundamental focar num ponto fundamental, que é a definição da Linguagem Formal dos produtos, definida como a principal tarefa do designer industrial, onde todas as diferentes metodologias se materializam em soluções. Esta definição de design, que combina a componente criativa e técnica, é referida por um dos maiores projectistas aeronáuticos, o designer Daniel Raymer, que afirmou:

> *"O design é uma disciplina separada da engenharia aeronáutica - diferente das disciplinas analíticas como aerodinâmica, estruturas, controle e propulsão. Um designer de aeronaves precisa ser bem versado nestas e muitas outras especialidades, mas na verdade passará pouco tempo a realizar estas análises (...) O tempo do designer é gasto fazendo algo chamado "design", ou seja, criando a descrição geométrica de uma coisa a ser construída" (Raymer, 1994, p.2)*[1]

Um designer industrial é mais do que apenas o criador da descrição geométrica da coisa a ser construída, pois deverá saber utilizar metodologias análogas às das ciências sociais quando desenvolve uma pesquisa de mercado e entrevista ou observa utilizadores; deverá ter a capacidade de comunicar conceitos e ilustrar ideias através do desenho; ser capaz de materializar conceitos em modelos matemáticos com recurso a software CAD 3D; recorrer à engenharia de produto, desenhar peças e construir protótipos; gerir recursos e pessoas. O foco desta investigação é, contudo, a Linguagem Formal desenvolvida pelos designers e nela se inclui a descrição geométrica dos produtos a construir bem como todas as suas propriedades visuais como a sua cor, materiais e acabamentos.

A investigação incide na Linguagem Formal desenvolvida no estúdio Almadesign, durante duas décadas de actividade. A Almadesign foi fundada em 1997 por Rui Marcelino e tem vindo a desenvolver projectos na área do Design de transportes, produtos e interiores - mais de 600 projectos - ao longo de 20 anos de actividade em Portugal. Embora cada projecto tenha a sua especificidade, em todos eles os designers desenvolveram uma Linguagem Formal específica, que foi considerada, a cada momento, a resposta mais indicada para uma determinada especificação. Essa Linguagem pode ser analisada à luz dos três vectores de investigação definidos – Contexto, Sintaxe da Forma e Semântica da Forma. Isto é, cada projecto foi desenvolvido num determinado contexto externo do estúdio (económico, social, tecnológico, cultural, etc) e interno do estúdio (designers, metodologias, processos, etc). Cada projecto desenvolvido apresenta elementos formais organizados segundo princípios de design, que constroem uma gramática formal a que chamámos Sintaxe da Forma. Cada um dos projectos - com o seu Contexto e Sintaxe - carregam consigo uma componente simbólica, introduzida pelos designers (de forma mais ou menos premeditada) e que é interpretada por clientes e parceiros. Formulou-se assim a questão desta investigação que é "será que existe uma Linguagem Formal específica desenvolvida na Almadesign?". Em caso afirmativo, será possível identificá-la e caracterizá-la? Para responder a estas questões, são propostos 3 vectores de investigação que podem ajudar a clarificar os objectivos:

[1] This author's translation

- **Contexto:** análise do contexto envolvente do estúdio em duas décadas de actividade, de uma perspectiva interna (designers, metodologias, processos) e externa (mudanças sociais, económicas e tecnológicas, história de design)
- **Sintaxe da Forma:** caracterizando os elementos formais desenvolvidos pelos designers do estúdio e a sua organização através de princípios de design;
- **Semântica da Forma:** caracterizando a criação de símbolos através do design do produto e a sua interpretação por clientes / parceiros;

Os produtos industriais são objectos complexos incluídos em ecossistemas também eles de grande complexidade. Cada produto tem uma função específica e desempenho que deve alcançar, o que pode ser conseguido através de diferentes definições geométricas, tecnologias de produção e materiais. No geral, a Forma, a Função e a Técnica estão interligadas no desenvolvimento de um novo produto e sempre que um destes componentes é alterado, os restantes são afectados. Os designers naturalmente abordam esses 3 elementos básicos de uma forma holística, num complexo ecossistema que inclui diferenças sociais, culturais, económicas, tecnológicas e de mercado. Enquanto estudante, o investigador sempre considerou que nesta equação entre os 3 elementos – Forma, Função e Técnica – faltava algo mais que fugisse à limitação da "Forma segue a Função". Factores humanos como as respostas psicológicas ao produto, a comunicação entre designers e utilizadores, a forma como os produtos nos fazem sentir, reflectir, etc, são tudo aspectos fundamentais na criação de produtos que não estão presentes nesta equação. Dessa procura nasceu o tema da investigação e o objectivo de estudar os processos de design com foco na linguagem formal, a sua sintaxe e semântica. De modo a estabelecer um universo específico de estudo, que incluísse o trabalho desenvolvido no estúdio e que respondesse a estas questões, foi definido como objecto de estudo a descrição geométrica do objecto, as suas cores, materiais e acabamentos e todos os factores de comunicação intrínsecos à actividade dos designers, isto é, as estratégias utilizadas na definição de uma Linguagem Formal para estabelecer a comunicação simbólica interpretada por clientes e parceiros. A seguinte hipótese foi colocada: "É possível identificar e caracterizar uma Linguagem Formal específica desenvolvida no estúdio Almadesign".

No sentido de provar a hipótese, foram definidas diferentes metodologias de investigação – mais empíricas ou mais teóricas – procurando enfrentar o desafio de identificar e caracterizar a Linguagem Formal do estúdio. As metodologias incluem a Revisão de Literatura sobre os três vectores de investigação – Contexto, Sintaxe e Semântica; Estudos Experimentais com alunos do Mestrado em Design e com designers profissionais do estúdio; Estudos de caso com clientes / parceiros, com base em projectos do estúdio. As diferentes metodologias foram planeadas, desenvolvidas e colocadas em prática num período de cerca de dois anos e meio, desde Julho de 2015 a Janeiro de 2018. Este documento apresenta o resultado dos dados recolhidos, da sua interpretação e conclusões, procurando definir o Modelo para o desenvolvimento da Linguagem Formal no estúdio. A identificação e caracterização de uma Linguagem Formal específica é uma tarefa complexa, já que se concluiu que a Linguagem Formal não é uma "receita", mas resulta de um complexo processo evolutivo, orgânico e em constante mudança, suportado por metodologias próprias do estúdio e diferentes equipas de designers, com uma liderança forte e muito presente ao longo de duas décadas.

Considera-se que o ponto de vista desta investigação é intrinsecamente enviesado, já que o investigador trabalha como designer na Almadesign há cerca de 16 anos. Paralelamente a esta actividade, o investigador lecciona também disciplinas de projecto de design na Faculdade de Arquitetura da Universidade de Lisboa desde 2007. No entanto, este contexto – a presença no Mercado e na Academia

- permite que o pesquisador tenha um ponto de vista privilegiado para aproximar as duas áreas, contribuindo para a transferência de conhecimento - essencial para desenvolver novas ideias, produtos e processos.

Através desta investigação e da identificação e caracterização de uma Linguagem Formal num Modelo único, o investigador espera contribuir para o corpo da teoria de design para que no futuro se possam aplicar processos análogos na análise de outras Linguagens Formais desenvolvidas noutros estúdios de Design. Espera-se por isso contribuir para a aproximação e transferência de conhecimento entre Mercado e Academia. Considera-se que outros processos investigativos serão necessários para aprofundar o conhecimento sobre a Linguagem Formal em estúdios de design, sendo neste documento apresentado um contributo para o tema.

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GLOSSARY OF TERMS

CMF: Colour, material and finish; service provided by a design studio in which the colours, materials and surface finishes are defined in order to establish a consistent product experience.

Communicative Function: Collective term for syntactic and semantic functions (Warrel 2001).

Design Consultancy: A company which provides design services.

Design Studio: Same as design consultancy.

Design Principles: Set of principles aimed at helping designers find ways to enhance usability, influence perception, increase appeal, teach users, and make sound design decisions during projects (Lidwell, Holden & Butler, 2003).

Ergonomy: Discipline that studied of the relationship between users and their environment.

Form: Physical, visual-spatial qualities of a product: external dimensions, shape, geometry, proportion, dimension, surface texture, structure and configuration.

Form Element: An element of the physical, visual-spatial form: line, shape, space, value, colour, texture:

Form Semantics: Product function related to the Sign's message.

Form Syntax: Product function related to the configuration of the visual form and its structure.

Gestalt: An arrangement of parts which makes them more than the sum of parts; a whole.

Industrial Design: Design discipline applied to products that are to be mass produced; this process - the creative act of defining a product's form is separated from manufacture and distinguishes industrial design from craft-based design.

Product: A system, object (or service??) which will respond to the needs of a customer.

Product Design: Activity which involves the design of products.

Product Function: The purpose of a product, which is met when the product performs it effectively and reliably.

Product Semantics: The study of the symbolic qualities of man-made forms in the cognitive and social context of their use and application of knowledge gained to objects of industrial design (Krippendorf and Butter, 1984).

Semiotics: The study of Signs.

Symbolic meaning: inclusion of semantic codes in the products (Gotzsch, 2000); also referred to as symbolic functions, which explain something about the product user or the socio-cultural context in which the product is to be used (Gros, 1975).

PART I - METHODOLOGY

PART I: METHODOLOGY

Structure of the document

This document is Volume I of the deliverable for the PhD investigation entitled: “The Form Language of Almadesign: A study on Context, Syntax and Semantics”. This document was developed over a period of two and a half years, from July 2015 to January 2018, at the Faculty of Architecture in Lisbon (FA-ULISBOA). The investigation was supported and supervised by Professors Rita Almendra and Rui Marcelino.

During this period, the researcher actively participated as a Partner and Design Manager in several Almadesign projects in Transport Design (Aviation, Railway and Automotive), Product Design and Interiors, including market projects and R&D projects (PT2020 and H2020). During the same period the researcher taught classes at the Masters and Bachelor Design courses at FA-ULISBOA.

This document is organized in six parts, each one divided in chapters. The structure is described as following:

- Part I: Refers to the Introduction and Investigation Design, including purpose and structure of the document, title, abstract, keywords, research questions, hypothesis, objectives, methodology, investigation design, planning and dissemination.
- Part II: Includes the Literature Review, organized in three separate chapters: Context (Almadesign History and Design History), Form Syntax and Form Semantics.
- Part III: Refers to the Experimental Studies developed during the investigation. It includes three separate chapters: Experimental study #1 – “Reverse Inspiration”, Experimental study #2 – “Box of Favorite Things” and Experimental study #3 “Visual Language of Almadesign”.
- Part IV: Includes three Case Studies developed for the investigation: Case Study #1 – “CAETANO WINNER”, Case Study #2 – “inTRAIN” Project, Case Study #3 – “LIFE” Project.
- Part V: This part integrates the main Conclusions of the investigation, the Almadesign Form Language Model, as well as suggestions for further investigation.
- Part VI: Includes References organized in Books, Papers, Websites.

Volume II of this document includes all the Annexes with relevant data collected from Experimental Studies and Case Studies, including spreadsheets, surveys, drawings and diagrams.

1 Investigation Design

1.1 *Title:*

"The Form Language of Almadesign: A study on Context, Syntax and Semantics".

1.2 *Introduction*

Industrial Design is an activity which employs different methodologies, from social science methodologies to art principles, from engineering processes to management practices. Being influenced by car design and aircraft design since its inception, Almadesign studio designers are highly skilled in the industrial design profession with a specific technical approach, due to the engineering background of its founder and collaborator profile throughout the years. Hence, for the context of this investigation, it was considered that a focus should be given the "form" component of the studio design language, defined as one of the focal tasks of the industrial designers. This definition is borrowed from aircraft designer Daniel Raymer, whose worke has been an influence on the studio's founder and researcher, who stated:

> "(Aircraft) design is a separate discipline of aeronautical engineering – different from the analytical disciplines such as aerodynamics, structures, controls and propulsion. An aircraft designer needs to be well versed in these and many other specialties, but will actually spend little time performing such analysis (…) Instead, the designer's time is spent doing something called "design", creating the geometric description of a thing to be built." (Raymer, 1989, p.1)

Products can be very complex artefacts in an ecosystem. Each product has a specific function and performance goal, which can be achieved using different shapes and could be produced in different ways, using different materials and finishes. Overall, Form, Function and Technique are always hand in hand in the definition of a project. If we combine the 3 elements into a diagram, we can see that they are closely interrelated and that whenever one of them is changed, the others are affected:

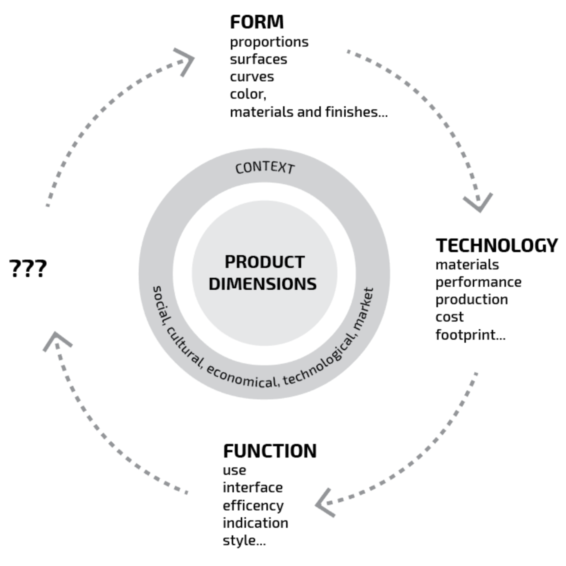


Figure 1 : Product dimensions (source: the researcher, 2015)

Industrial products are complex objects included in ecosystems which are also very complex. Each product has a specific function and performance goals, which can be achieved through different geometric definitions, production technologies and materials. In general, the Form, Function and Technique are interconnected in the development of a new product and whenever one of these components is changed, the rest are affected. Designers naturally approach these 3 basic elements in a holistic way in a complex ecosystem that includes social, cultural, economic, technological and market differences. As a student, the researcher always considered that in this equation between the 3 elements - Form, Function and Technique - something else was missing that escaped the limitation of the "Form follows Function" Modernist view. Human factors such as psychological responses to the product, communication between designers and users, how products make us feel, etcetera, are all fundamental aspects in creating products that are not present in this equation. These questions started to be addressed in Design theory during the eighties and gave birth to different theories such as Gros' Theory of Product Language. From an initial research on Product Language, the researcher tried to figure out how to apply these theories to the work developed at Almadesign studio, where he works as a designer. In order to establish a specific universe of study which would include the work developed in the studio, it was decided to focus on the Form Language as the "geometric description of the products developed, its colors, materials and finishes" trying to identify specific elements, constants, principles and trying to interpret how the symbolic communication developed by the designers was interpreted by clients and partners. The following hypothesis was put forward: "It is possible to identify and characterize a specific Form Language developed at Almadesign studio."

Almadesign is a Portuguese design studio founded in 1997 by Rui Marcelino, a Mechanical Engineer, Master in Transportation Design and PhD in Design. The company started as a design consultancy for a bus manufacturer in Portugal, Salvador Caetano, but soon extended its activities beyond transportation design towards product design, interior design and design management activities. Marcelino refers to Almadesign's mission as a studio which "drives innovation through design, developing user-centered technology-based solutions mainly for Transports, Product and Interiors" (Marcelino, 2012). The company is believed to have four main assets, which have been contributing to its success: an experienced team; the ability to manage design processes and apply evolving product development methodologies; business diversity and cross-pollination between different industry areas; 20 years of experience in the design and development of products for the market (Marcelino, 2012). The studio has its own design methodology, which comprises several product development phases, from initial Research and identification of Requirements, to Concept generation, Development, Prototyping and Communication / Marketing. In the latest years Almadesign has invested a lot of effort into developing R&D projects and had, for several years, a Research, Development and Innovation Management System (Portuguese standard NP4457:2007). It is strongly focused in partnerships and actively engages in fostering cooperation networks such as PEMAS (Portuguese Aeronautic Association), PFP (Portuguese Railway Association), COTEC (Business innovation association) and FORUM OCEANO (Portuguese Nautical Association). The researcher has been collaborating with Almadesign since 2001, and has been a partner since 2009, having participated in most of the company's projects through the last 17 years, which include more than 600 design projects.

The main objective of this investigation is to study and characterize the Form Language developed over two decades of design projects. The researcher believes that it is possible to identify and characterize a specific design language developed at the studio, which can be analyzed at different complexity levels. So a hypothesis is stated, where the researcher proposes to characterize the language in the light of three different vectors:

- **Context:** analyzing the context of the studio in two decades of activity, in the perspective of internal (designers, methodologies, processes) and external contexts (social, economic and technological changes, design history);
- **Form syntax:** characterizing the studio's Design Elements and its organization through Design Principles;
- **Form semantics:** characterizing the studio's creation of Symbolic Meaning through product design and its interpretation by clients / partners;

It the objective of the investigation to identify and characterize the Form Language in order to improve processes, methodologies and eventually better prepare the company' designers for the future. It is also the objective to create a Model for the development of the Form Language, which can be used as a tool to analyze other studios and design practices. Parallel to his activity at Almadesign, the researcher has been teaching design at FA-ULISBOA for the last 10 years. This context allows the researcher to have a specific point of view from both the Market and the Academia perspectives, which can eventually help in bridging the gap between these two entities, enabling the knowledge transfer considered essential to developing new ideas, products and processes.

A series of different methodologies, both empirical and theoretical, were applied to the investigation in order to tackle the challenge of identifying and characterizing the Form Language of the studio: Literature Review on the three investigation vectors; Experimental Studies with both students and studio's professional designers; Case Studies with clients / partners, based on studio's projects. These methodologies were developed through a period of about two and a half years, and the data gathered, conclusions and Form Language Model are some of the results of this investigation. It is considered that the point of view of the investigation is intrinsically biased, as the researcher has been working at Almadesign for the past 17 years. Nevertheless, this approach also meant that the researcher had access and practical knowledge on the methodologies, projects and people involved, which provided a very significant input to the research.

During the two decades of design work at Almadesign, the context and market conditions in Portugal, Europe and the World have changed rapidly, together with exponential technological changes. But the management and core team of designers at Almadesign (and most of its clients) have been stable throughout the years, creating a company "culture" which is defined by its processes and methodologies, and which is clearly influenced by its leadership. By characterizing the Form Language developed at the studio, the researcher expects to contribute to further develop the company's methodologies and visual culture, helping the team deal with future challenges and develop the appropriate design strategies.

Further research will be needed to develop a deeper knowledge on this subject, nevertheless, it is considered that the investigation was able to identify and characterize the most important features of the Form Language development at Almadesign.

1.3 *Research questions*

The Research question states the following problem:

- "Is it possible to define and characterize a specific Form Language developed at Almadesign studio?"

This question evolved into three sub-questions, by which the investigation design was defined and developed. These questions concern three different ways of looking at the framed question – three research vectors - which are related to Context (in what way is the language related to internal changes in the team of designers as well as external social, technological and market factors?), to Form Syntax (with which form elements and design principles has the form language developed)) and to Form Semantics (how is the Form Language is perceived and/or interpreted by clients and partners?). The following sub-questions were stated:

- Sub-question 1: "In which Context did the Form Language develop?"
- Sub-question 2: "How can we define the Form Syntax developed?"
- Sub-question 3: "How is the Form Semantics interpreted by clients/partners?"

1.4 *Hypothesis*

The following hypothesis was formulated: "It is possible to identify a specific Form Language developed at Almadesign studio and to characterize it through different complexity levels: a changing Context (social, technological and market), a specific Form Syntax (form elements and their organization in design principles) and Form Semantics (symbolic elements interpreted by clients and partners)."

1.5 *Objectives*

The following objectives are stated:

- **General level:**
    - To identify and characterize the Form Language developed at Almadesign studio to contribute to the practical and theoretical design knowledge.
- **Personal and professional level:**
    - To improve Form Language development strategies and market knowledge to cope with future design challenges for the studio and the design profession (social, technological and market challenges).
- **Academic level:**

- To build a theoretical framework – Model - which can identify and characterize the Form Language of any given design studio, contributing to the knowledge transfer between the design profession and the Academia.

1.6 *Investigation Design and Planning*

The investigation design was an iterative, organic document, which changed and evolved throughout the research process. Although it served as a guideline to structure the investigation process, it evolved naturally over time, changing and adapting according to the work developed, conclusions and lessons learned from the different methodologies. The basic structure was discussed with the supervisors and developed between August 2015 and February 2016, with the research question as the focal starting point.

From here on a Experimental Study was developed, Experimental study #1 – "Reverse Inspiration". This study, developed together with design students from the Design Master Course at FA-ULISBOA, helped confirm the hypothesis and refine it with the 3 investigation vectors and sub-questions: Context, Form Syntax and Semantics. Each of these questions raised the definition of a specific theoretical field to be explored in the literature review: Literature Review #1 on Context (Form Language history and Almadesign history). This preliminary approach to the literature review was followed by a preliminary draft of Case Study analysis framework and to the first Report (LAB1) in July 2016. This methodology is graphically described in figure 2 and can be summed up in the following steps:

SEMESTER I and II:

1. Definition of the investigation question.
2. Experimental Study #1 – Reverse Inspiration: Student exercise at FA-ULISBOA for critical analysis and moodboard generation based on design projects from Almadesign and other competitor studios.
3. Definition of the investigation sub-questions (and vectors): Sub-question 1; Sub-question 2; Sub-question 3.
4. Literature Review #1: Form language history and Almadesign history.
5. Draft framework for Case Study analysis.
6. LAB 1 Report and Jury presentation (July 2016).

SEMESTER III:

From August 2016 on, a Preliminary framework for Case Study analysis was further developed, as well as the Literature Review #2, on Form Syntax. This Framework, and the choice of Case Studies, allowed for a first Case Study analysis of Project CAETANO WINNER. Another Experimental study was developed, this time involving current and ex-designers from Almadesign. This Experimental study, named "Box of Favorite Things" was prepared, implemented and preliminary analyzed during the last months of 2016 together with a revision on the Framework for Case Study Analysis. From the results of this study, a revision of the Literature Review on Form Language history was developed, to accommodate the information collected during the study with the studio's designers and their visual culture. These processes led to the LAB 2 Report and Jury presentation in January 2017. The methodology can be summed up as:

7. Preliminary Framework for Case Study Analysis.
8. Literature Review #2: Form Syntax and revision of Review #1 on Form Language history.
9. Case Study #1: preliminary analysis of Project CATEANO WINNER.
10. Experimental Study #2: Favorite Things: exercise with professional designers.
11. LAB 2 Report and Jury presentation.

SEMESTER IV:

From January 2017 on, Case Study #2 and Case Study #3 were developed as well as the Literature Review #3 on Form Semantics. A third Experimental Study, involving Almadesign clients and partners was prepared, developed and implemented from April to June 2017 resulting in Experimental study #3 – Visual Language of Almadesign. These processes led to the LAB 3 Report and Jury presentation in July 2017. The methodology can be summed up in the following steps:

12. Literature Review #3: Form Semantics
13. Case Study #2: project INTRAIN
14. Case Study #3: project LIFE
15. Development and implementation of Experimental Study #3: "Visual language of Almadesign"
16. LAB 3 Report and Jury presentation.

SEMESTER V:

From July 2017 on, the preliminary analysis on the results of the Experimental Studies was devised. The same process was followed for the Case Studies. The structure of the final document was prepared, including the definition of the chapters and some of the writing. The Model for Almadesign Form Language was developed in the last months of the year, discussed with the supervisors and refined in a final version. A draft document was finished and proofed in January 2018. The methodology can be summed up in the following steps:

17. Experimental Studies: revision of data and conclusions.
18. Case Studies: revision of data and conclusions.
19. Document structuring, writing and final literature review.
20. Development of a Model for Almadesign Form Language

The investigation design was not a straight-forward process and, as in all design processes, was subject to changes, adaptations and iterations. The graphic description in Figure 2 depicts the investigation design – activities and milestones - and intends to represent some of these iterations and revisions during the investigation process. Albeit no including all the iterations and evolutions over time, hopefully it will serve as a contribution and guideline for future investigation processes.

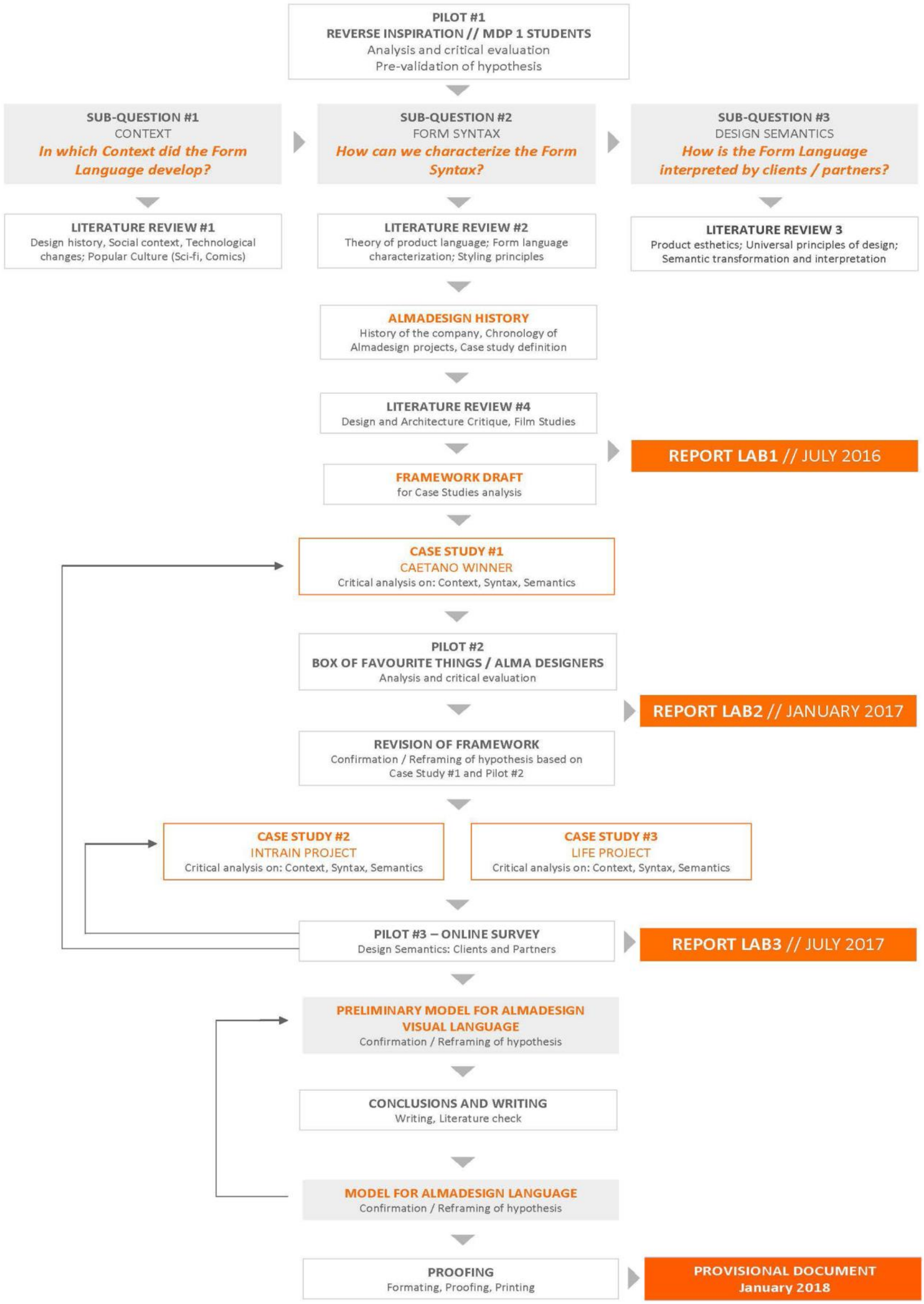


Figure 2 : Investigation Design (source: the researcher, 2017)

Figure 3 shows the final planning of the activities during the 5 Semesters of the Investigation. A larger format of both Investigation Design and Planning Activities can be accessed in the Anexxes.

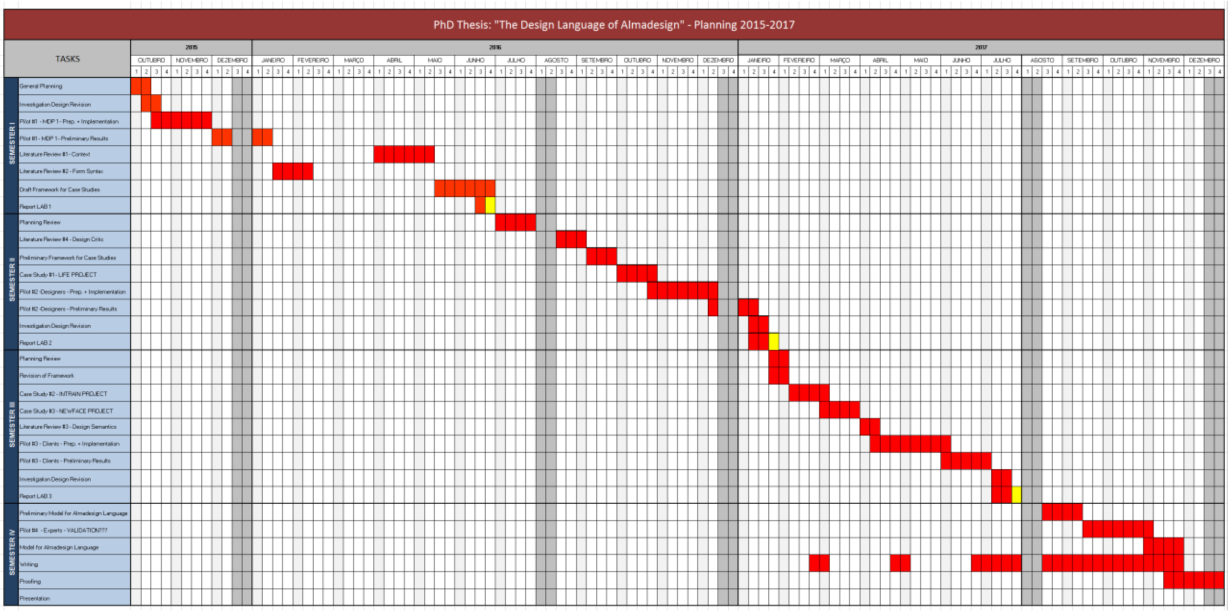


Figure 3 : Planning 2015-2017 (source: researcher, 2017)

1.7 ***Dissemination***

This investigation was presented at the Fórum Cultural – Bienal de Cerveira, at the Escola Superior Gallaecia, Vila Nova de Cerveira, Portugal in August 2016. The presentation was included in the EU funded “Project Tempus 2013” Conference organized by the design school. An abstract proposal including parts of the work developed during this investigation entitled “Educational strategies for developing Form Language in product design” was submitted by the researcher and accepted for the “International Conference on Engineering and Product Design Education” to be held in September 2018 at the Dyson School of Design Engineering, Imperial College, London, United Kingdom. The results of the investigation have also been actively disseminated during Design Classes in the Masters Course at FA-ULISBOA.

PART II – LITERATURE REVIEW

PART II: LITERATURE REVIEW

Structure of Part II

The aim of Part II – Literature Review is to establish a theoretical framework for the research based on the review of texts from different authors on the three investigation vectors: Context, Form Syntax and Form Semantics. It is expected that this theoretical framework is capable of sustaining the empirical activities, aiming at a deeper analysis of the practical work but also reframing the investigation questions and methodology by trying to find references to support processes and findings on previously developed research. From an initial list of authors and texts selected by the researcher and supervisors, new texts and authors were added along the process, to build a consistent framework for the empirical investigation – Experimental Studies and Case Studies – as well as for the development of the Model for Almadesign Form Language. Taking into consideration the three research vectors – Context, Syntax and Semantics – this Part is divided into three chapters, each referring to one of the vectors. This part is structured in the following way:

- Chapter 1 presents the literature review on the investigation vector "Context", including Almadesign studio history and Form Language (design) history;
- Chapter 2 presents the literature review on the investigation vector "Form Syntax", including a review on texts about Form Elements and Design Principles;
- Chapter 3 presents the literature review on the investigation vector "Form Semantics", including a review on texts about Theory of Product Language, Semiotics, Communication Models, Social and Cultural associations;

1 Context

1.1 *Introduction*

The aim of this chapter is to establish a theoretical framework around the investigation vector "Context", defined as the background or set of circumstances that surround the foundation and development of the Form language in the industrial design profession, but also about the design studios (or design consultancies) that emerged with the profession and of which Almadesign is an example. In this sense, Almadesign studio, a late 20th century portuguese studio, can trace back its 20 years of activity to a lineage of design consultancies and as such, a brief historical backgroung context was considered to be relevant for the research. Being a profession which deals with market, social and technological aspects, these are elements that cross the research and frame the context around the Form Language development.

1.1.1 Objectives

The following objectives were set for this chapter:

- To describe an "Almadesign history" over the last two decades;
- To describe the "Form Language" in design history over the last two centuries;

1.1.2 Methodology

An initial list of authors and texts selected by the researcher and supervisors were analysed in the light of the first research vector, Context. As the research developed, new texts and references were added whenever considered relevant. A review on the studio's communication media – books, websites, brochures - articles published and the researcher's personal account of the work in the studio were used to establish an Almadesign historic reference frame. The researcher, being a part of the studio's design team since 2001, used his personal experience to illustrate the chapter together with collected material. Main sources for the review were:

- Almadesign website;
- Almadesign year books: 10, 15, and 20 commemorative editions;
- Articles about the company on newspapers and magazines ;
- Researcher's personal experience.

A review of fundamental texts on industrial design history and Form language developed during the last two centuries was developed, trying to connect the dots between the main social, technological and market changes. The visual culture of the designers (choices of products and designers which resulted from data gathered in Experimental Study #2) was used as a framework for this chapter. Main sources for the literature review were Bernard E. Burdek, Carma Gorman, Markus Caspers, Krippendorf and Butter.

1.2 *Almadesign history: 20 years of practice*

Almadesign was founded by Designers José Rui Marcelino, Paulo Bago D'Uva and Carlos Castelo Branco in 1997. Following the experience of Rui Marcelino as an intern at the Alfa Romeo design studio in Italy (1996), a Master Degree in Transport Design (SPD, 1994-1995) and Mechanical Engineering degree from IST Lisbon (1989-1994), the designer founded Almadesign on the promise of developing a bus design for manufacturer Salvador Caetano, commemorating 50 years as an automotive manufacturer. At the time Portugal had a striving economy, leveraged by the EU membership in 1986, and the mass modernization of its infrastructures, companies and qualifications, leading to the organization of a World Fair, the Expo 98. Figure 4 illustrates one of the first work developed by Rui Marcelino with Almadesign for the "Aquamatrix" show at the Expo 98 in Lisbon.

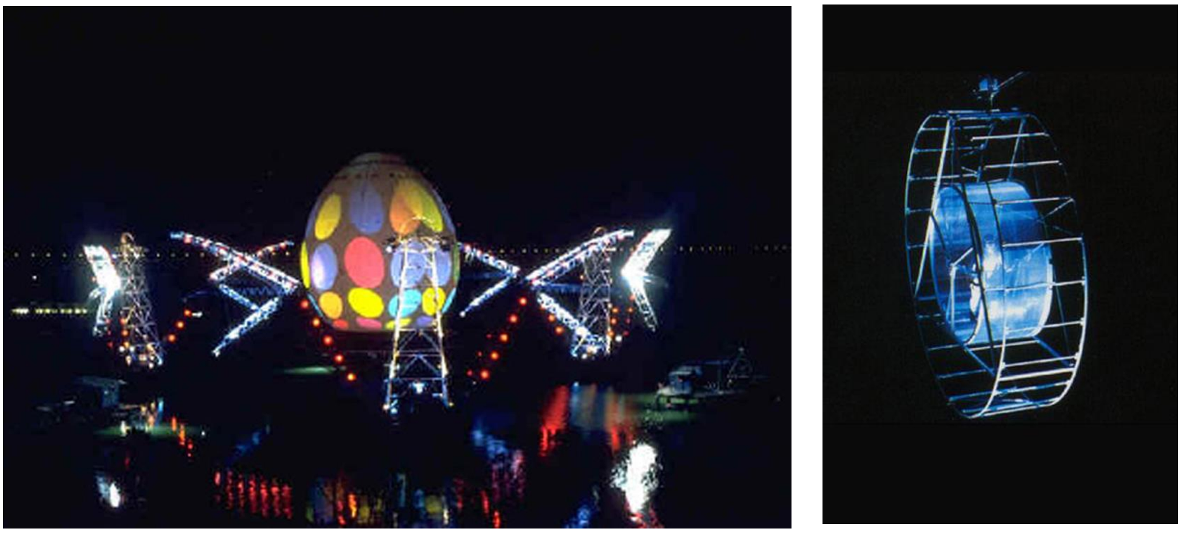


Figure 4 : Aquamatrix design for EXPO 98, photo in the event and scale model (source: Almadesign, 1998)

The first transport design assignment was indeed for Salvador Caetano, a coach manufacturer in the north of Portugal, and one of the few Portuguese brands developing transport products at the time (although Portugal had a few cars manufacturing facilities, including Salvador Caetano's own Toyota factory, models were produced for other brands and not fully developed by in-house departments). There were a few manufacturing facilities in Portugal for international automotive brands such as Toyota, Renault, Citroen and Opel, due to the fact that before joining the EU, there were heavy taxes for imports which led OEMs to develop assembly facilities in the country. Salvador Caetano had its own factory and 50 years of experience with an engineering team in-house developing new buses. Rui Marcelino found an opportunity for introducing a design culture in a company that could develop a product "from scratch" and launch it in the market. The specification for the first project came directly from Salvador Caetano administration, who devised a brief to substitute their old model named "Delta" coach. The new project should be something entirely new, to commemorate the company's 50 years in building coaches, and Rui Marcelino accepted the challenge and gathered a team of three designers to start developing the new product. Almadesign was thus born in a small office in Oeiras, Portugal. The first major transport project of the studio was named the "Enigma" coach, and Marcelino himself worked on the initial sketches and development. Figure 5 depicts one of his concept sketches for the bus, from 1996:

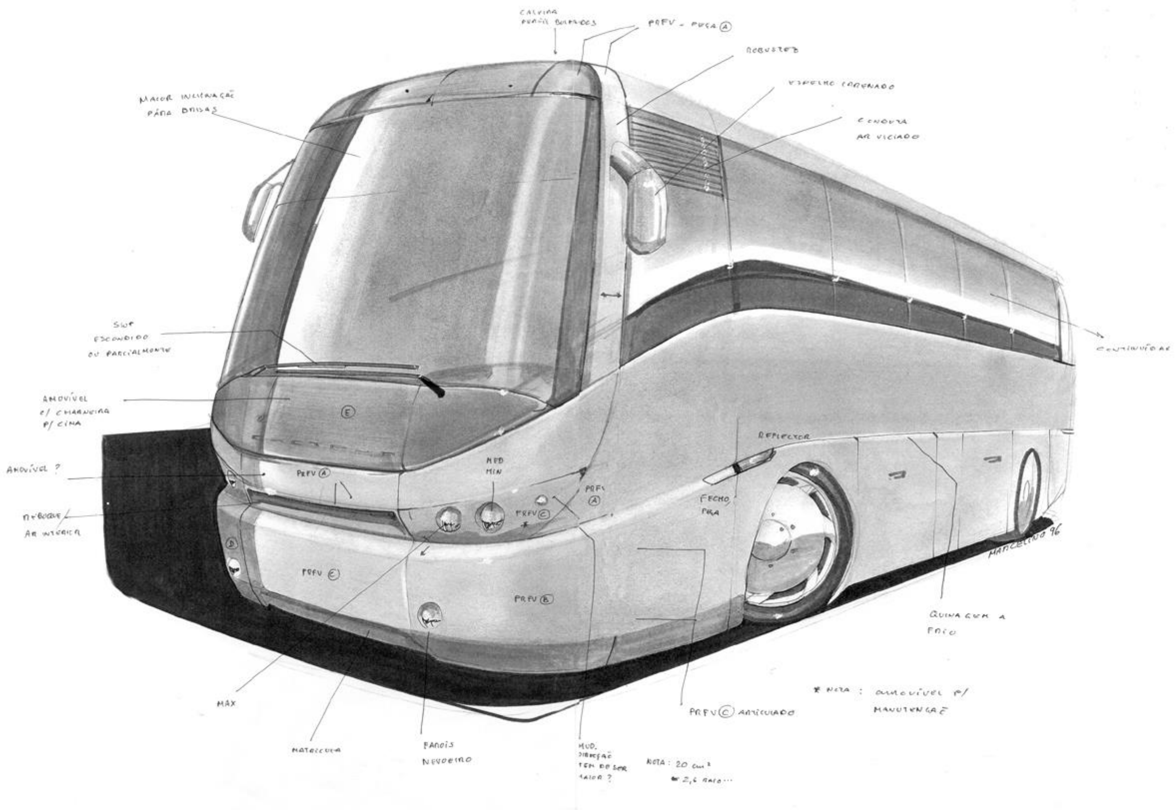


Figure 5 : Enigma Coach, concept sketch (source: Rui Marcelino, Almadesign, 1996)

The next two decades would see the studio grow, develop its own methodologies, culture and design processes, developing over 600 design projects in the areas of Transport, Product and Interiors. In its mission statement in 2017, top management states:

> *"Almadesign drives innovation through design, developing user-centred technology-based solutions mainly for Transports, Product and Interiors. To carry out this work effectively and consequently, the studio is grounded in four main assets: 1) The excellence of an experienced team which has been growing sustainably; 2) The ability to manage design processes and apply product development methodologies that continuously evolve; 3) The business diversity and its contribution to cross-fertilization experiences that lead to innovation through design; 4) The experience from the lessons learned in all project development phases and successful products launched in the market together with our customers" (Marcelino, 2012, pp.10).*

Some of the studio's designs have been very successful in the market, such as the Enigma, Winner, Levante and Cobus coaches, with hundreds of units sold worldwide. But the company has also developed projects for Aviation and Railway industries, some of them used by millions of passengers such as the Cabin interiors for TAP fleet or the Alfa Pendular refurbishment for EMEF / CP.

During its two decades of activity different periods can be traced, marked by changes in the studio partners and team of designers, but also by the typology of projects and clients, by the international presence and awards collected. At least four different periods are considered for this research, which can be traced back in the history of the company. Rui Marcelino refers to these periods in the commemorative edition which marks the 15th anniversary of the studio:

> *"In 2007, for our 10th anniversary, Almadesign presented the studio's projects in a book called "10". Our goal was to reinforce and communicate the company´s track until that moment, but also to honour the clients who believed in our work, the partners with whom we collaborated and the people who made up our team, the soul ("Alma" in portuguese) of Almadesign (…) To remember what we did in the past drives our passion to create new products, that hopefully will enhance people's life and contribute to our customer´s and partner´s success and sustainability. (…) Five years later the same reasons lead us to edit a new book, which naturally is called "15". In the current economic and social development context, to maintain and grow a professional team of designers, to develop new projects and increase international recognition is another good reason to celebrate and reflect." (Marcelino, 2012, pp.9)*

For the research purposes, we will chronologically divide the history of the company in four periods of around five years each, described as follows, and have a look at which were the main events, projects, processes and culture changes over the years:

- 1997-2001 – The early years: describing the foundation of the company an including some of the initial clients and important transport projects as the Enigma Bus.
- 2001-2007 – Growing up: development of a larger portfolio of clients and the successful products such as Winner Coach and Cobus Bus as well as the collaboration with important new clients such as Adira and Sony Portugal.
- 2007-2012 – Cross-pollination: the development of an innovation strategy and collaborative projects launched the company in a series of important R&D efforts enabling it to create a network of partners and a portfolio of innovative solutions.
- 2013-2017 – Knowledge transfer: after the R&D years, where the company gained competencies in different areas of expertise, the development of market projects for the Aviation and Railway industries became a reality, with flagship projects as the retrofit of the Short and Long-haul fleet of Portuguese airline TAP and the refurbish project for the Railway Alfa Pendular for EMEF / CP.

1.2.1 1997-2001 – The early years

In 1997 Portugal was in a booming economic period. GDP was growing more than 4% per year[2] and Portugal was "catching-up" with the most developed European countries. A lot of infrastructures were being built and investment was being made in several economical activities. This was the time for EXPO 98, the international fair organized in Lisbon, with dozens of countries and 6 months of cultural activities in the city. Many companies emerged and flourished from the need to design, plan and build a new area in the eastern part of the Portuguese capital. A lot of IT companies and architectural design offices were created and this was an optimistic time for the Portuguese market, with projects, construction and cultural activities. Almadesign was founded by Rui Marcelino when he was collaborating with stage design for EXPO 98 and for a new bus project for Salvador Caetano, the Enigma Bus.

Activities from 1997 to 2001 include both concept proposals and developed products, for transport, interior, graphic design and show design concepts. About 100 projects were developed, many of them as concept proposals, not fully developed for production. Transport design was a big focus since the beginning of the studio, with the three partners having a transport related background in design schools. Naturally, designs for buses, motorcycles and boats were one of the outputs of the company at that time. But being a startup, other areas were pursued in order to maintain a steady workflow, which meant working for different markets such as show design, interior / retail and product design projects with the same core design team. Also, during this period a great emphasis on communication design was given mostly due to the early days of the internet, which earned the company a website design prize in 1998. The Enigma project for Salvador Caetano was developed during this period and the relationship with the company started to develop. Other projects, such as the Cobus airport buses started in 2000, but were halted due to the 9/11 attack, and would be developed in the next period.

The team evolved from the three core partners (one of them left after a year) to six product designers, web designers and administrative managers. The office was shifted to a larger space in Cascais municipality. Designers were mostly former students from IADE design school in Lisbon, where one of the partners (Paulo Bago D'Uva) was a teacher. This university was renowned from the good balance between graphic and product design.

Process included a methodology where an initial research on the project and its themes was developed, followed by hand sketches painted with markers which were used to present the concepts to the clients for selection. The first CAD models were already used for the development phase of the design to build the 3D geometry, visualize concepts and parts. In the very beginning of the company Alias software and 3D Studio Max were standard tools, but they were quickly replaced by cheaper, reliable alternatives such as Rhinoceros nurbs modelling tool. For the graphic contents, Photoshop and Freehand were used in most cases. Hand sketching and markers were very much the means used in the concept design phases as well as model making – typically using Styrofoam. A lot of models were built such as Buses, Automotive and Nautic concepts. From study models to final

[2] (source: www.pordata.pt, accessed Nov.2017)

models, model making "by hand" was one of the main processes developed internally. The Internet was still in its early years and was a tool only accessed by a few, specifically top management and administrative tools. Management of projects was done via printed documentation on physical files. Designers did not use e-mail in their communications and only very seldom the Internet for research purposes. Visits to trade fairs, specifically to Milan Design Fair, were a resource for market knowledge and trend research.

The studio Form Language was very much influenced by original partners – Rui Marcelino, Carlos Castelo Branco and Paulo Bago D'uva - and their experience as students in Italian design schools. Some Form Elements identified in later projects were already present in the early concepts such as the use of flowing lines, aerodynamic profiles, clear surfacing and strong graphics separating different functional parts of the design. Process wise, the initial hand drawn sketches were mainly the responsibility of Marcelino (also Castelo Branco). There was always the will to fulfill the "promise" when presenting a design to a client that is to try and develop a product without compromising the "look and feel" of the concept sketch. In a specific project, the "Le Mans" car, we already can see an influence of Rui Marcelino's background (mechanical engineering and aerodynamics) on the way the aerodynamic elements - spoilers and ailerons - and the cooling systems - air ducts - are included in the sketch of the vehicle (Figure 6). The detailed and technical ability of the designer is also apparent in the way the 3D surface model (Figure 7) was developed, keeping the proportions and design elements form the sketch. Another interesting example is Marcelino's proposal for Porto 2001 opening event (Figure 10): a vehicle for a street parade for the opening ceremony of Porto Culture Capital in 2001, aimed at connecting "past and future", "humans and technology", "tradition and future". The designer used a central element - a transparent sphere - as the driver's place, referenced in the drawing as the "astronaut". These references both to space and sci-fi are already present in the initial sketches as well as the "boomerang shaped" steel structure which is also a reference to Porto's Eiffel bridge (D. Maria bridge). The vehicle is also shaped "like an animal" with stretched legs, and its topped by a wooden barrel referring to Porto's winery tradition. The sketch sums up a lot of interesting design elements, both functional and metaphorical, which the studio (under Marcelino leadership) will use in future projects: speed metaphors such as the boomerang, anthropomorphic and body / machine language references, a sci-fi / space-age inspiration. The following figures depict some of the first projects from the studio with sketches from Rui Marcelino (Figure 6, 7, 8 and 10) and Castelo Branco (Figure 9).

Figure 6 : Concept sketch and 3D CAD model for IST Le Mans vehicle (Almadesign 1999)

Figure 7 : Enigma Coach: Interior photo, Exterior photo and concept sketch (Almadesign, 1997)

Figure 8 : Enigma II Coach: sketch and final product photo (Almadesign, 1999)

Figure 9 : Scooter concept sketch (Almadesign, 1999)

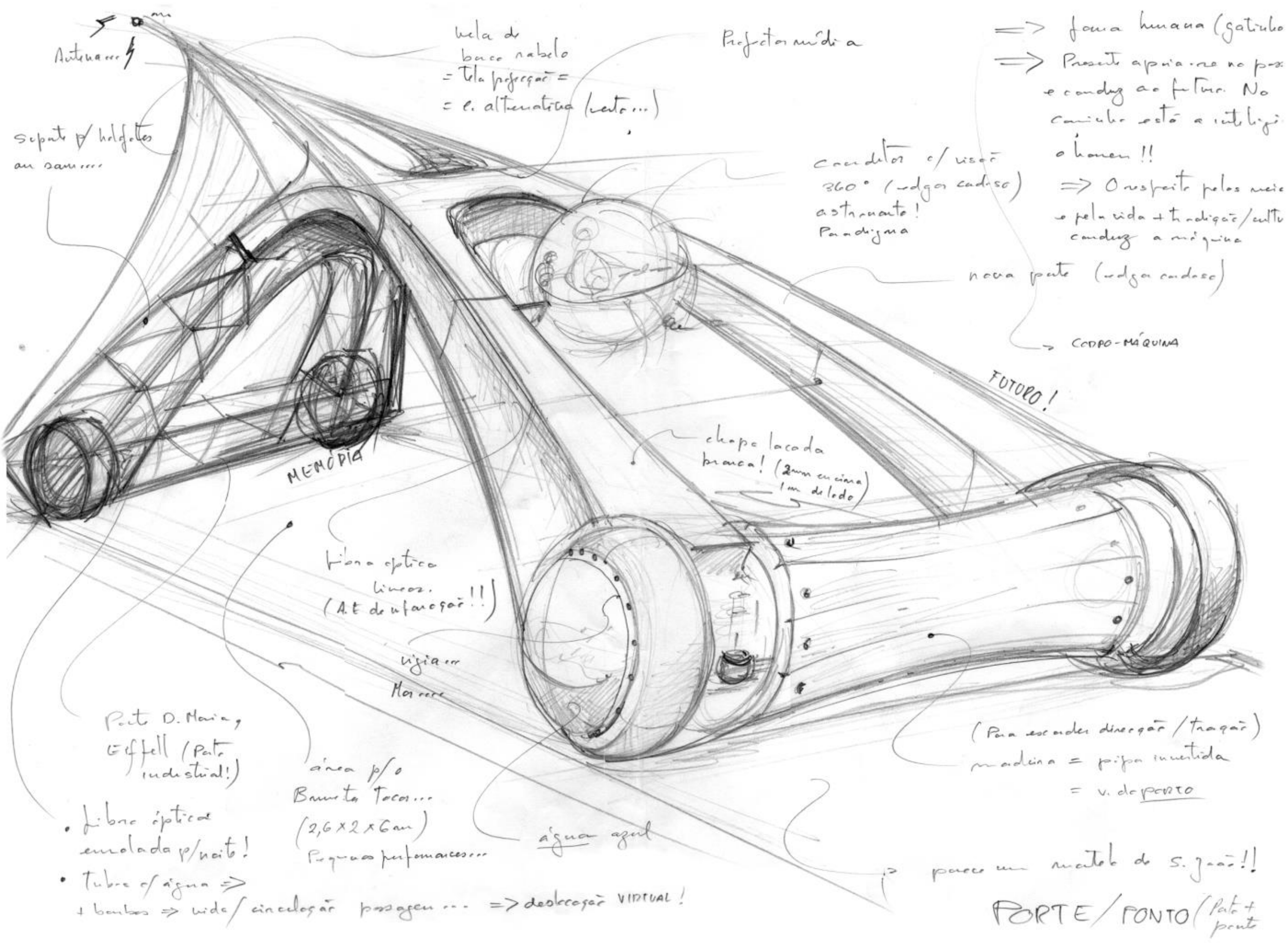


Figure 10 : Sketch for the opening ceremony vehicle for Porto 2001 (Almadesign, 2000)

Main Projects of the early years were the development of the Enigma Bus (1999), the Optimo 2K Bus (2000), Enigma II (2000), the work done for EXPO 98 (Aquamatrix show and moving sculptures with Teatro o Bando, 1998), and several graphic and communication design as well as websites. A first railway project was also developed EMEF. Prizes include the CPD Award for the Enigma Bus in 1998 and the IEE WEB Design prize for the Almadesign website in 1998.

1.2.2 2001-2007 – Growing up

From 2001 to 2007, Portugal's economic growth stalled. A big event was hosted, EURO 2004, for which Almadesign developed some projects for the stage design (specifically the "caravels" for the opening and closing ceremonies). A huge investment was made in the construction of 12 new stadiums, but the economic return was not as expected. The country would enter a financial crisis in the next years. Nevertheless, Almadesign was able to develop new designs with industrial clients such as Adira and a lot of retail projects with Sony Portugal and Sonae (Worten). The investment in retail spaces allowed for a constant flow of work and the studio developed more than 60 projects for both clients. The studio also developed transport products for its main client, Salvador Caetano (rebranded as Caetanobus) and also furniture for Paços de Ferreira, the Portugal "capital" of furniture makers which exporting their products to external markets. This was also the time for Trade fair design at the studio, specifically for furniture and industrial machinery companies, which invested in participating in trade fairs in Portugal and abroad. Transport products such as the Caetano COBUS bus for airports were given a go after the halt following the 9/11 in New York city. It was during this time that the company started to interact with Brazil in view of collaboration projects, specifically with aircraft manufacturer Embraer.

Activities from 2001 to 2007 include concept proposals and developed products, transport, interior, graphic design and show design concepts. More than 150 projects were developed, many of them as concept proposals and built products. Projects included buses, industrial machinery and furniture for Portuguese manufacturers, and interior spaces for retail, all of which were the main clients of the company at that time. With less emphasis on communication design as a separate discipline and more as included in a global design strategy, the studio developed different projects for Caetanobus, Adira and Animóvel, projects that ranged from the product to the promotion brochure, website and trade show fair stand. For Caetanobus a major project was developed, the substitute of the Enigma Bus – the first Almadesign assignment - which would turn into the bestselling product of the company, the Winner Coach. Developed as the Levante Coach for the British market, it became the most successful project from Almadesign in terms of production numbers and sales.

Over the years the team changed and so did the partner structure. Rui Marcelino became sole partner of the company and only two interns were kept from the team prior to Summer 2001. The team was shortened and had four members (3 designers and 1 administrative officer) by the end of 2001, with two of them coming from FA-ULISBOA. The company changed its headquarters to the technological park in Oeiras – Taguspark – where it would stay for the next 10 years. Process wise, the studio still included the same methodology, where an initial research on the project and its themes was developed, followed by hand sketches, painted with marker and presented to the clients for selection. The first experiences with using Software tools such as Photoshop were tried out during these years, from 2001 to 2004. Software tools and 3D models were used for the development phase of the design to build the geometry and visualize concepts and parts using Rhino and Cinema 4D to visualize and render. in the ternet started to be used for market research and for e-mail for the designers, which enabled a different organization and work distribution, with the birth of the "project manager" under the top manager. Visits to trade fairs continued to be a common practice, specifically to Bus and furniture Fairs but also to Aviation sector Fairs such as Aircraft Interiors in Hamburg, from 2004 on.

Photographs were now digital and kept in a digital archive. Budget quotes, communication with clients and subcontracting were organized via e-mail. With a bigger facility and some new tools, drawings could also be printed in 1:1 scale for prototype build. The use of 3D files for the development of a whole product such as a Bus were used just after the Winner coach was developed. From then on, all the development tools would be fully digital. Before this every new prototype was fully built by hand in Caetanobus from 2D technical drawings sent by the designers and engineers. The first completely digital model, in terms of bodywork and structure, was the Optimo Seven Mini Bus, which started a new age in the digital development of bus design.

During 2005, another Software tool, Solidworks was added to the studio's software portfolio as well as a new rendering tool, Flamingo for Rhino. This enabled a simplification of processes using one software to model and to render – Rhino + Flamingo – and 1 software for engineering / development – Solidworks. The studio started to use rapid prototyping tools to build models, specifically with partners who used technologies such as SLS (selective laser sintering). This enabled the development of scale models, typically used at the end of the design process to present to the client or to keep a repository of projects, shapes and design language culture in the studio.

During this time a few projects were developed other than client's projects. They were called “desalmados” (soulless) and were exercises in styling and design development to direct the attention of potential clients. The studio also participated in some design competitions as the case of the Bus of the Future competition. In these cases, the design solutions and Form Language was freely developed without specific technical constraints and allowed for a greater freedom. This was a process analogue to the one used by the automotive industry in the “advanced design studios” where designers are given the freedom of creating a vision for the future, materializing ideas in physical prototypes. Form Language developed was very influenced by the top management and the team of core four designers who were part of the studio at the time. An example is the Winner coach and the Optimo coach which pursued a new Form Language for Caetanobus, and by which the digitalization of the processes was developed.

The work developed for Animovel resulted in furniture lines which enabled the company to work with different materials and finishes – wood, lacquered paint, textile, etcetera – and for which a specific Form Language was developed. This approach can be seen in two options which were selected by the client: Tribu line, of a simple, minimalist Form Language (Figure 11) and the Venus line with soft curved surfacing, clearly influenced by transport design language (Figure 12). Another important client, ADIRA, was rebranded by the studio, through the use of a new Form Language in which the shape, color and trim played an important role. From a color scheme which used green colors and heavy duty machinery Form Language, the studio developed a lightweight, white and blue Form Language, turning industrial machinery into a clean, high-tech precision representation of technology (Figure 13). Another client, Frilixa (Figure 14), made possible the use of a common design language using sculpted, curved fibre glass and polyester panels in their line of products. On the interior of the buses, a lot of work went into developing dashboards and driver's areas, opening up the first projects in which the user interface was the focus point.

A very important learning curve was developed with the retail design projects, specifically for Sony Portugal, in which a specific Form Language was developed and refined. A continuous flow of surfaces, simple shapes with rounded corners, a careful color and trim option with white and black surfaces, hints of color and a careful treatment of light, created a Form Language which was developed and refined in over 60 projects. During this period the studio joined enterprise associations and leveraged its networking, specifically in the aviation sector with the PEMAS association (Rui Marcelino would become its president) and with contacts with Embraer Brazil. The first R&D projects applications were started during this period, which would turn out to be the most appropriate strategy to cross the years of financial crisis. Projects of this period include the Furniture Line Venus (Awarded by AIMMP), the Winner and Levante coach (Figure 15, 16), the OPTIMO bus (Figure 17).

Figure 11 : Concept sketch and final product photo: Tribu furniture line (source: Almadesign, 2003)

Figure 12 : Concept sketch and final product photo: Venus furniture line (source: Almadesign, 2003)

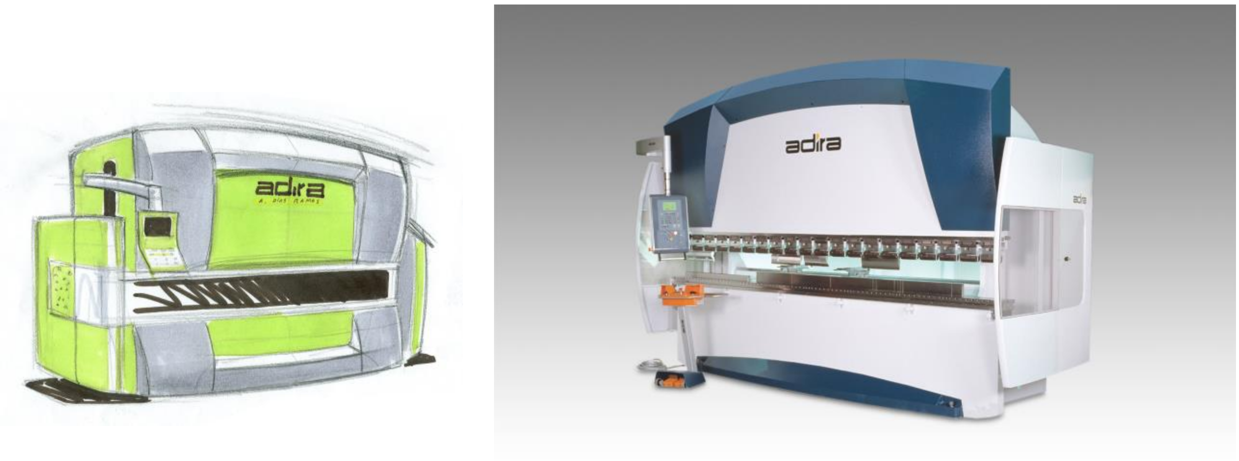


Figure 13 : Concept sketch and final product photo: Adira press-brake machines (source: Almadesign, 2003)

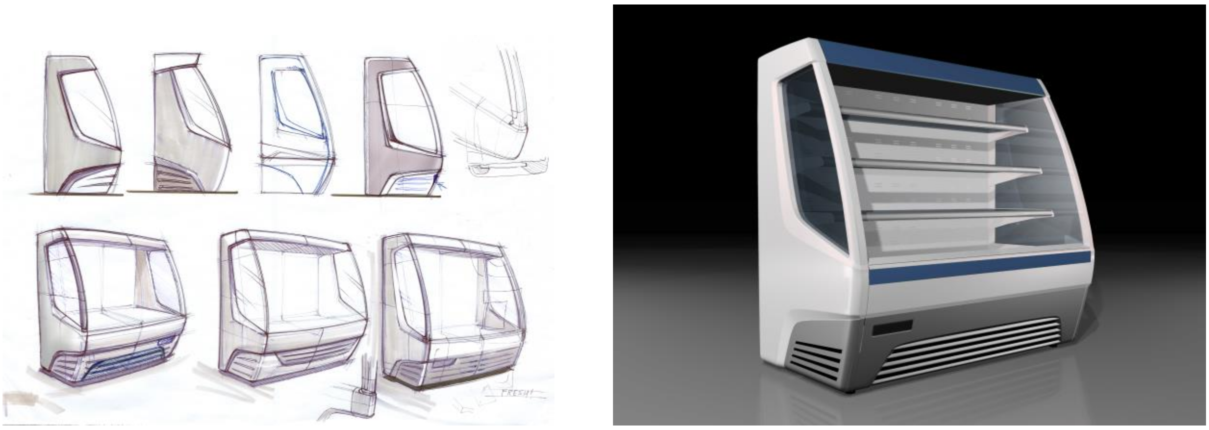


Figure 14 : Concept sketch and final product rendering: Frilixa freezer (source: Almadesign, 2003)

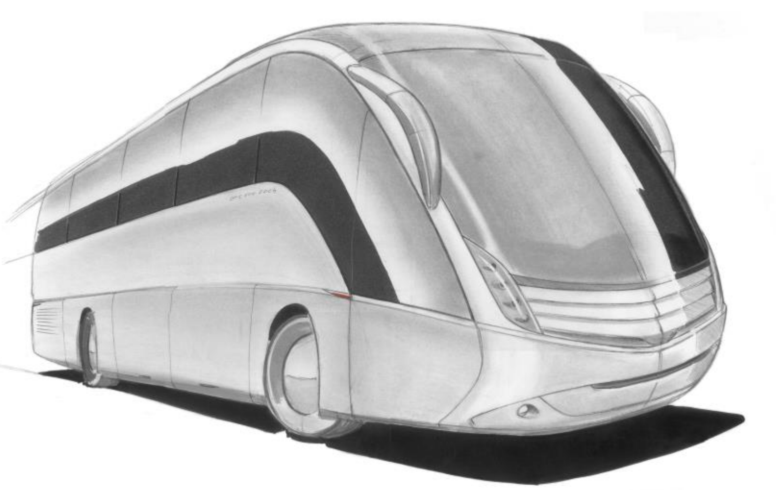


Figure 15 : Concept sketch for Winner coach (source: Almadesign, 2003)

Figure 16 : Winner coach: Concept sketch and final product photo (source: Almadesign, 2003)

Figure 17 : Optimo bus: final product photo, GOOD DESIGN Award (source: Almadesign, 2004)

Example of retail projects for SONY Portugal can be seen in Figure 18. This was a time when companies were investing in new retail spaces and the market was changing rapidly, with shopping malls opening almost every month throughout the country. With such an expansion of large scale retail spaces, the market would soon change and get saturated.

Figure 18 : Sony retail interiors photo (Almadesign, 2006)

The Cobus bus, developed and manufactured in Portugal is present in about 70% of international airports in the world, with a very successful market share. It was designed by Almadesign and developed with CaetanoBus engineering department together with the German company Cobus industries. The bus is manufactured in aluminum, fibre glass and thermoformed plastic parts (Figure 19). This is one of the most successful products from Caetanobus and a new generation was design, developed and produced in 2016.

Figure 19 : Cobus Airport Bus: sketch and final product photos (source: Almadesign, 2006)

Figure 20 : Rebus: future bus concept competition, renders (source: Almadesign, 2006)

Several R&D experiments were born during these years, such as the Rebus bus of the future concept (honorable mention in an international RETHINK competition, Figure 20) in which the studio's designers created a vision for the bus of the future. Another example is the railway project named RIS, developed with Portuguese industry partners and presented at an international trade fair of the sector. The project envisions several concepts for a high-speed train interior with different Form Languages: Embryo concept, with soft round surfacing and the Nautic concept which embodied the Portuguese tradition in nautical design (Figure 21) based on the idea of a "first-class cabin" for a train. The project was developed and presented at a Railway Interiors Conference in 2006, with very good feedback from the industry.

Figure 21 : RIS: high speed train interior concept renders (source: Almadesign, 2006)

These first R&D experiences were the genesis of a strategy of R&D investment and partnerships with companies and research institutes which the studio would develop in the next five years, and which are described in the next pages as the period of "cross-pollination".

1.2.3 2007-2012 – Cross pollination

From 2007 to 2012, the financial crisis hit Portugal and its companies. The country was bankrupt and included in a Troika programme (European Union, International Monetary Fund and European Central Bank) which lasted from 2011 to 2014. The GDP fell to -4% and unemployment raised from 10% to over 16% in three years. During this time the studio managed to keep up the design work, but there were some changes in the business and market, specifically with the retail clients, as the market stalled. It was during this time that the company invested in R&D projects and in an innovation strategy and network of partners which allowed it to maintain its activity despite all the economic problems.

Activities from 2007 to 2012 include concept proposals and developed products, transport, interior, graphic design and show design concepts. More than 200 projects were developed, from concept proposals to developed and industrialized products. Projects included buses, train interiors, aircraft cabins, industrial machinery, furniture, etc. With a clear focus on developing R&D efforts to gain competencies and market, the company invested heavily in a strategy which comprised different activities as described in the figure below (Figure 22):

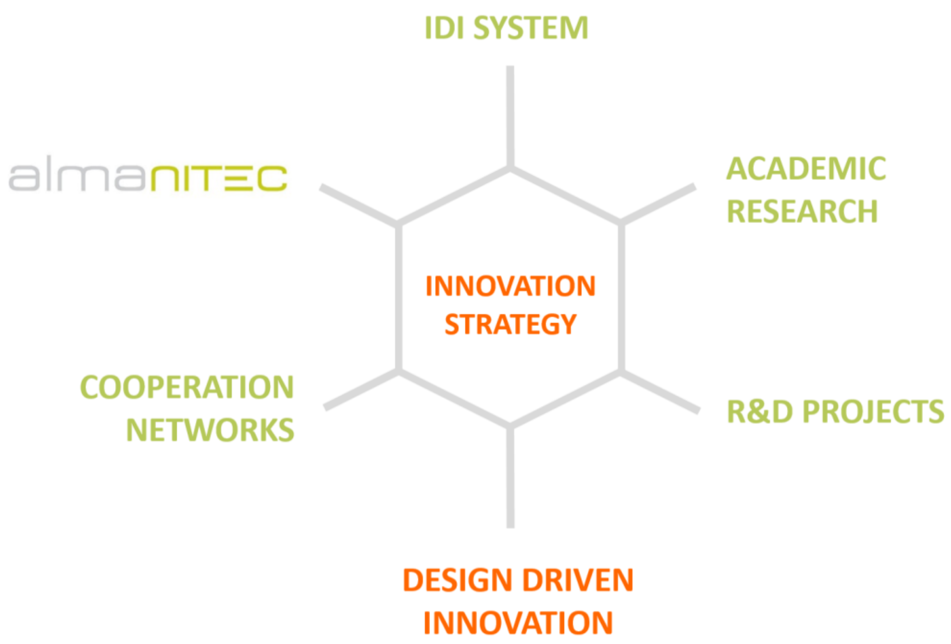


Figure 22 : Almadesign: R&D strategy (source: researcher, 2016)

The strategy was based on a series of activities which started with the creation of an innovation lab at Almadesign (named Almanitec) in which a specific prototyping laboratory was assembled and R&D projects were developed, specifically the ModuloBus project in which modular solutions were devised for coaches and buses. Two of the studio partners (Rui Marcelino and the researcher) enrolled at the Faculty of Architecture as students and later as teachers. This connection to the

Academia eventually brought new processes, investigation methodologies and contact with young designers and new practices. On other hand, the cooperation networks such as the PEMAS association (Portuguese aerospace industry association) were joined and fomented at Almadesign, creating a network of partners and connections. Several R&D projects were developed from this dates on, in consortiums of Portuguese companies which gathered together to design and produce innovative solutions (Figure 23).

Projects such as MODULOBUS, IBUS, ISEAT, LIFE were developed during this period, enhancing the companies R&D knowledge, leveraging competences, building networks, capacitating designers in collaborative work, project management, etc. They resulted in the creation of demonstrator prototypes, analogue to prototypes in the automotive industry and Almadesign worked as the conceptual integrator of different expertise and competences between partners, with design as the guiding and management tool to bring ideas from concepts to prototypes (just as with the automotive advanced design studios). This culminated in a series of successful projects with the Portuguese industry and also with the certification of Almadesign within the SGIDI system (Management Systems for Research, Development and Innovation). This innovation strategy, resulted in a qualitative leap for the studio and the recognition of pears with several international awards.

Figure 23 : Almadesign: cooperation networks (source: researcher, 2016)

Besides the R&D projects, the studio still developed a large activity with its main clients, Caetanobus, Adira, Amorim and also the Sonae group with several projects developed for their retail brand shop systems. For Caetanobus a major project was developed, the substitute of the Cobus Bus and the first “diesel to electric transformation” for an airport bus. The Levante II coach was also developed during this stage. The team changed and evolved, growing up to ten people, including nine designers. The researcher became a partner of the company and a new headquarter was chosen after 10 years in Taguspark. The studio moved to the center of Paço de Arcos, next to the sea. The studio also opened an office in Óbidos for the R&D efforts as an “advanced studio” for the development of R&D projects near the old town of Óbidos in the center of Portugal. Process wise, the studio’s methodologies were further developed: while maintaining the “sketch on paper” approach in the preliminary phases of the projects, digital tools were developed to present concept illustrations; 3D CAD models were used for the development phase of the design using Rhino and VRay for Rhino; model making capabilities were enhanced by means of a prototyping CNC machining tool assembled with the innovation LAB, Almanitec. Internet and software tools for project management were used throughout the team to manage the more complex (and longer) R&D projects with different partners and stakeholders. This adaptation brought a lot of knowledge and gathered new project management competencies. Further on, regarding the design process, a bigger investment in moodboards with specific themes for the concepts as well as materials boards for color, material and finish definition were now starting to be used due to the R&D projects which led the opportunity to invest in such a tool. This would become a fundamental asset for future coming projects. The treatment of every image of the studio was now more detailed and carefully planned, with the post-production of the images being made with more detail and quality.

An investment in visits to trade fairs was supported by an FP7 European funded internationalizing project named I-Alma to help support travel expenses. The presence in all the trade fairs for buses, aviation and railway was a fundamental strategy to show the studio’s work abroad, and several abstracts for presentations at industry conferences were proposed and accepted. This allowed for the company designers to have the privilege of presenting the company’s work and ideas to groups of experts at international events. Complex projects and prototypes were built during this period with the support of several partners: IBUS, ISEAT or LIFE were designs fully developed by the studio and built as 1:1 full scale mock-ups. The studio designed, developed and coordinated several teams with design acting as the main project management responsible.

The first electric and autonomous vehicle designs were developed during this period, such as Cybercar but also the Futi electrical car and several design studies in mobility such as the hybrid Fifteen project. These were also styling exercises which developed some of the studios Form Language themes further. The R&D projects replaced the “desalmados” (soulless) projects as the “advanced design” studio practices, with a lot of future design proposals bringing internal knowledge and presenting skills to potential clients.

In the R&D projects, creativity and liberty helped designers to develop new ideas and concepts. There was a lot of influence from cross-industry or cross-pollination strategies, in which different aspects from aviation, automotive design, interior design, etcetera were used as an inspiration for the development of new projects: IBUS project brought the aviation design into the bus industry, ISEAT project marked the development of novel lightweight material solutions for railway (full composite seat structure) and LIFE project marked a paradigm shift in the use of natural materials for executive jet interiors, mixing with high-tech innovative solutions with a nature inspired Form Language and natural materials and finishes.

The retail design marked a clear focus on modular and system strategies to develop a collection of products which could be easily used for different layouts and options. The studio developed capabilities of CMF with market research in materials and suppliers and the building of an in-house material library. The Form Language of the studio was developed in several projects, some of which will be analyzed as Case Studies (project inTRAIN and project LIFE). In terms of the company's own brand image, all the communication supports were redesigned and methodologies and processes were communicated in much more detail in different promotional supports (brochures, books, website, etcetera). Influenced by the presence of different designers and by the Academia experience, the communication became more "process" (Figure 24).

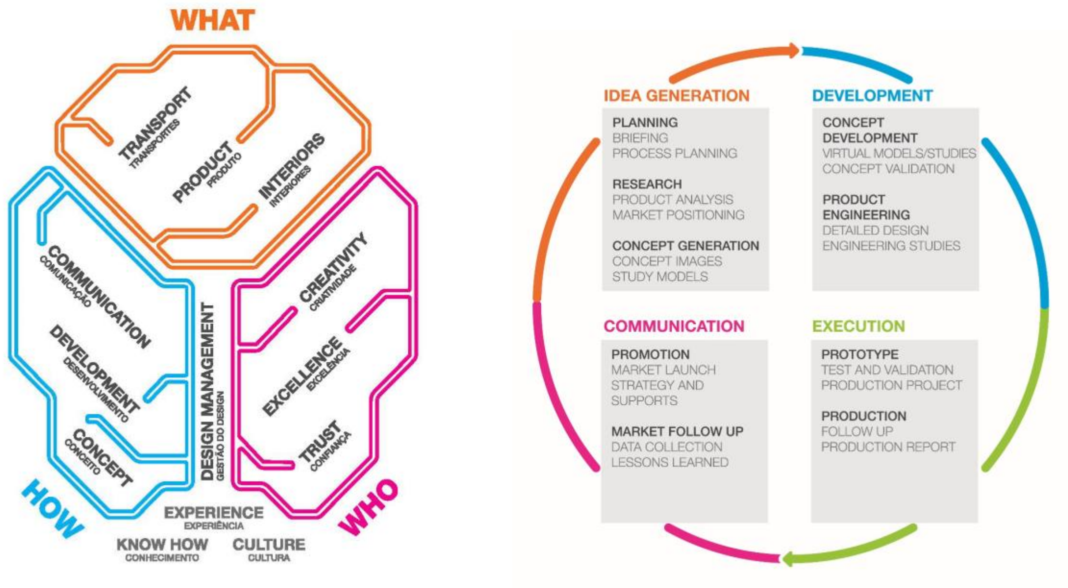


Figure 24 : Almadesign: process model and service models in 2012 (source: Almadesign, 2012)

The R&D projects, the cooperation networks and the innovation methodologies led the studio to a qualitative leap in the complexity of the design projects and Form Language. A few examples are interesting to show in this context such as IBUS - Integrated research and development of interior and exterior components for Coach Buses (Figure 25), Good Design Award project ISEAT - Integrated Research and Development of components for railway seats (Figure 26), and Crystal Cabin Award project LIFE - Lighter, Integrated, Friendly and Eco-efficient Aircraft Cabin (Figure 27) which will be presented as a Case Study during this investigation. These projects presented new challenges as they involved 5 to 7 company partners of different areas and proposed the development of design concepts and full scale mock-ups in 24 to 36 months. The complexity of the projects and the size of the different company's teams led to a learning curve design management and project management as well as the ability to integrate different capabilities and work towards a common design-led result.

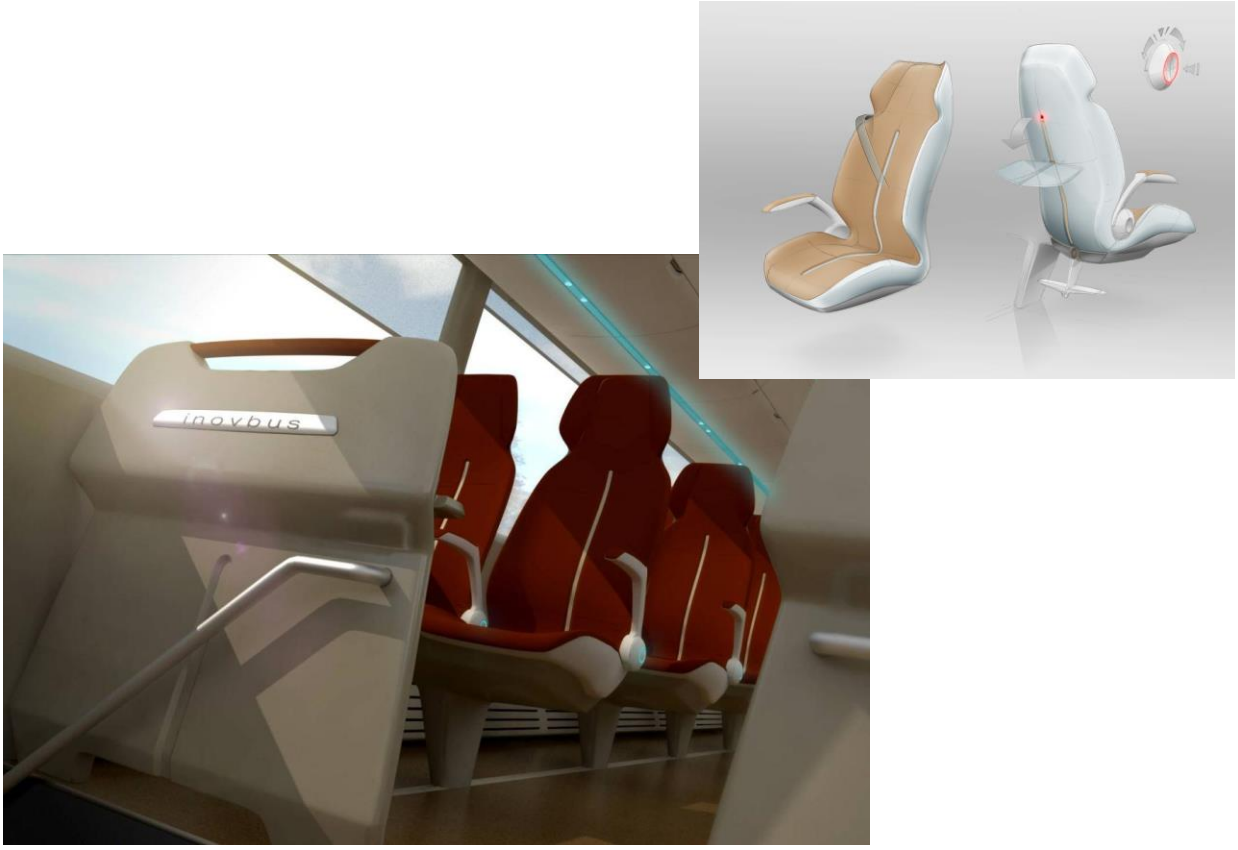


Figure 25 : Project IBUS: sketch and interior renders (source: Almadesign, 2009, 2010)

Figure 26 : Project ISEAT: sketches (left) and renders of the fina product (right) (source: Almadesign, 2010)

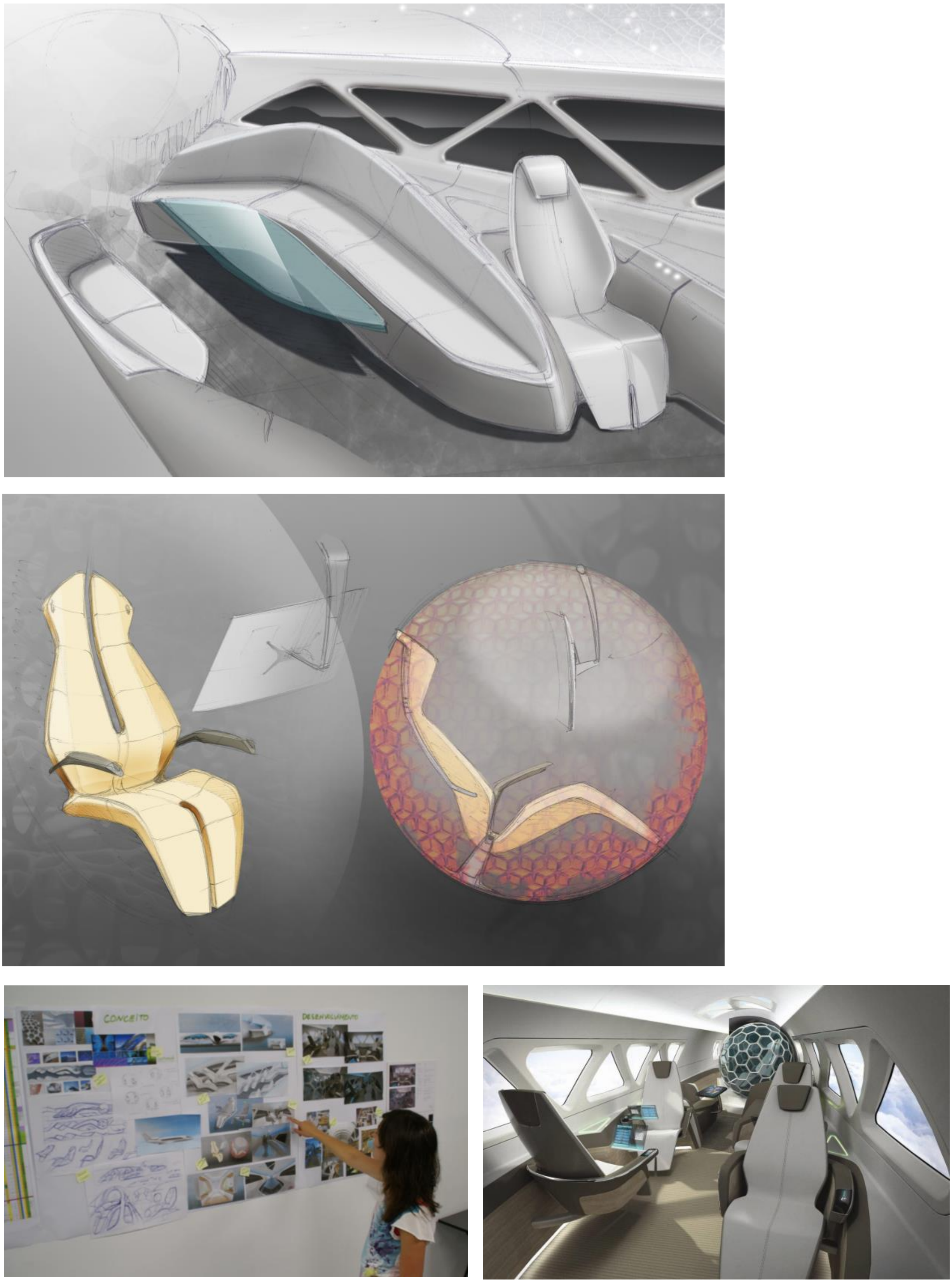


Figure 27 : Project LIFE: sketches (above), process (below left), renders (below right) (source: Almadesign)

1.2.4 2012-2017 – Knowledge transfer

From 2014 (the year Portugal left the Troika programme) to 2017, Portugal emerged from the financial crisis and the economy started growing again, fueled by tourism and exporting companies. Unemployment rates went down to 2009 values (8,8% in 2017, according to the National Statistics Institute - INE). The growing economy allowed for new investments from Portuguese companies, which allowed Almadesign to complete important projects for transport clients such as TAP, EMEF and CP.

Activities from 2012-2017 could be named a “knowledge transfer” for Almadesign. From the innovation strategy developed in earlier years, the company could now leverage knowledge about design projects across different industries and markets, specifically transport, product and interiors markets. Thus, a lot of effort was put into understanding these markets, both at a consumer level or at a technical/manufacturing and industrial level. This was developed together with universities, industrial partners and entities from the SCT. In achieving good results with the projects, being able to to build demonstrators, some of them tested and all of them communicated and disseminated, the company got the possibility to create large networks of partners and communication channels. The studio actively participated in the most important events of the industry together with the collaboration of partner companies and institutes. The permanent contact with both worlds – Market and Academia - enabled the tacit knowledge transfer, both at an individual level – personalized level – with Almadesign collaborators involved in R&D projects and also at the process level – codification - via the conversion of the knowledge into documents, images, prototypes, etcetera, specifically done in the context of the Innovation certification process.

> *“Two kinds of knowledge transfer mechanisms have been noticed in practice: Personalization and Codification. Personalization refers to the one-to-one transfer of [knowledge] between two entities in person (…) On the other hand, codification refers to the act of converting knowledge into knowledge artefacts such as documents, images and videos that are consumed by the knowledge recipients asynchronously (…) The underlying assumption that there is a potential for increased collaboration between industry and universities is also underlined in much of the current innovation literature”.*
> *(https://en.wikipedia.org/wiki/Knowledge_transfer)*

This knowledge transfer not only brought internal results to the company, in terms of better competencies – project management, design engineering, tooling, prototype building -and a growing network of partners and dissemination channels, but it also helped other companies achieve the same goals in the co-creation processes of the work developed. All companies and institutes beneficiated with the knowledge transfer. In specific projects, such as inTRAIN or LIFE projects, what happened was beyond the simple knowledge transfer, as it opened new markets for the studio: these two projects were the “seeds” which led to the development of the refurbish project for the Alfa Pendular (the “high speed” train in Portugal) and for the retrofit of the TAP (Portuguese airline) fleet. This also led to the development of new services due to the specific development of new competencies inside the company, such as the CMF (color, material and trim) department.

Projects such as CP Alfa Pendular, TAP retrofit programs, inTRAIN, newFACE, desAIR, PASSME, Flexcraft, Modseat and PASSARO were (and are still) being developed in this period. These projects, specifically the industry ones (CP and TAP), directly applied all the knowledge gained during the R&D research project. These continue to fuel the studio's R&D knowledge, leveraging competences, building networks, capacitating designers in collaborative work, project management, etcetera. Some of them resulted in the very successful creation of demonstrator prototypes such as inTRAIN (1:1 mock-up of a train carriage for urban service), newFACE (3 future aircraft configuration for eco-efficiency for 2030), desAIR (with the introduction of a corkbased recyclable composite material for aviation use) or PASSME "Personalized Airport Systems for Seamless Mobility & Experience", a H2020 EU funding initiative about rethinking the Airport experience with 12 companies, universities and research institutes from Europe. The so-called innovation strategy, resulted in the practical application of knowledge in the market and industry, thus combining innovation, collaborative work and cross industry experiences into knowledge transfer.

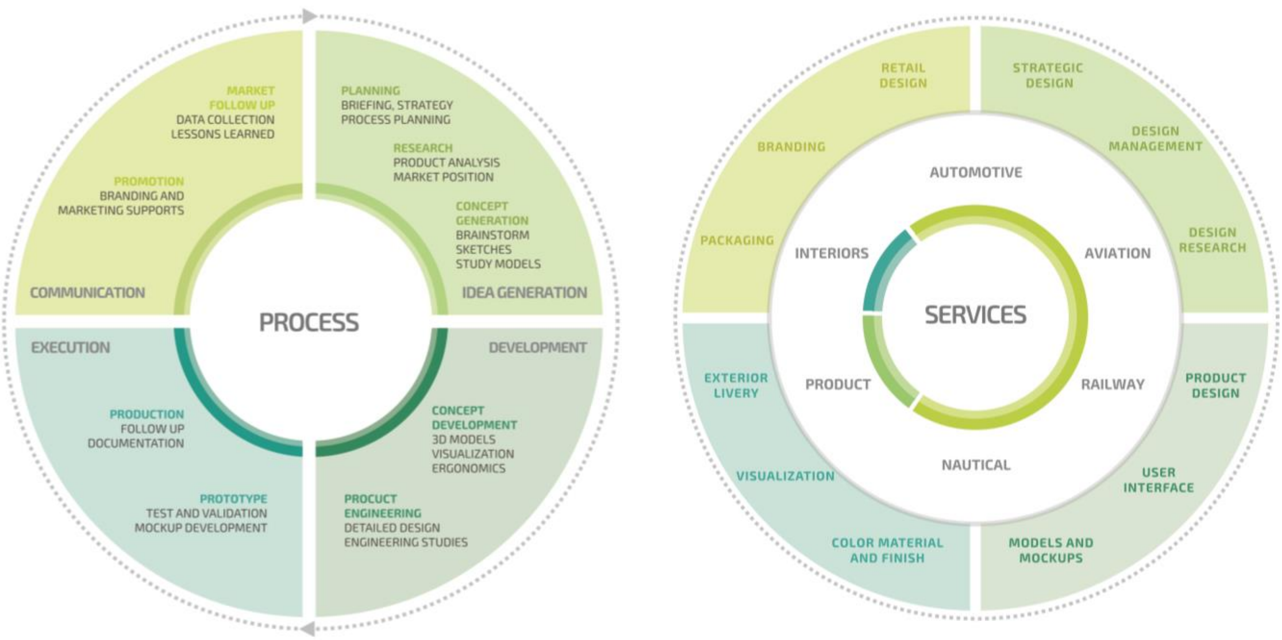


Figure 28 : Almadesign: process model and service models in 2017 (source: Almadesign)

The studio continued to develop its activity with its industrial clients such as Caetanobus, Adira, with several efforts and work developed for their products. For Caetanobus a major project was developed, the substitute of the Levante, Levante III one of its biggest selling coach and the development of the first fully electric bus, Urbano Electric, implemented in cities across Portugal from 2018 on.

The team changed and evolved, growing up to 12/14 people, including 11 designers and engineers and 2/3 people for studio management. Internationalization efforts continued, with a very clear focus on the dissemination via the publication of articles in international renewed magazines, participation in conferences as speakers, workshops, etc. Process wise, the methodologies were further developed, specifically with the inclusion of aviation standard software CATIA to develop aircraft projects and the inclusion of rapid prototype machines in the Studio’s LAB, namely SLA and FDM technology. These enabled designers to further prototype in early phases of the projects as well as provide the service of building final models for clients in-house.

Design language evolved in the 5 years from 2012-2017 with the most important projects being inTRAIN (Fig.29), newFACE (Fig. 30), TAP (Fig.31), ALFA Pendular (Fig.32) and a brand-new coach for Caetanobus, the Levante (Winner III). In the R&D projects, the continuous creativity process could create future thinking possibilities and liberty for designers to develop new ideas and concepts. A lot of influence from cross-industry strategies (aviation, automotive design, interior design, etc) but also from popular culture and SCI-FI can be seen in a lot of projects such as NEWFACE and INTRAIN. A specific project / competition for the transport system for Jeddah city was developed during this period with London based architecture studio HOK enabling the company to develop a future design language for a whole city transport system.

Regarding the communication of the studio, an extra careful attention was given to the presentation of these projects, with specific videos for presenting and disseminating them in new channels. Also, in terms of communication, the company started to use social networks, such as linkedin and facebook, which ran parallel to other media such as newsletters and revised website. Some of the projects developed, specifically the newFACE project, were extensively used in different media as “eye catchers” for Industry Conferences on the theme of future mobility systems (e.g. Electric & Hybrid Aerospace Technology Symposium 2017). The studio has become one of the players in these industry events where normally Rui Marcelino presents the latest projects developed.

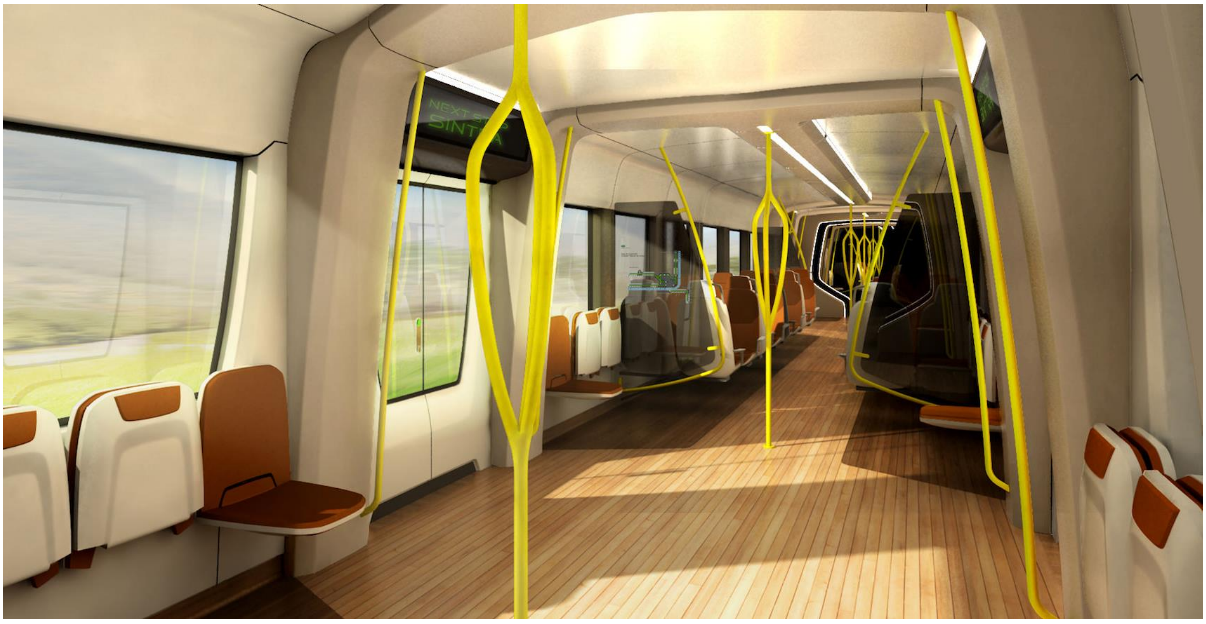


Figure 29 : Project inTRAIN, final product renders (source: Almadesign)

Figure 30 : Project newFACE, exterior and cabin interior renders (source: Almadesign)

Figure 31 : Project TAP A330 Retrofit, final product photo and render (source: Almadesign)

Figure 32 : Project Alfa Pendular, final product renders (source: Almadesign)

Synthesis of the chapter

The aim of this chapter was to establish a theoretical framework around the investigation vector “Context”, defined as the background or set of circumstances that surround the foundation and development of the Form Language of Almadesign studio. Main objective was to describe the “Almadesign history” in the last two decades, since its foundation.

The first part was based on the researcher’s own experinece as a designer at Almadesign and with documents gathered from the studio (studio’s comemorative books, articles, website, etcetera). Regarding “Almadesign history” the main findings of this chapter would be the way the researcher organized the different work periods of the studio: the “early years” (1997-2001), “Growing up” (2001-2007), “Cross-polination” (2007-2012) and “Knowledge transfer” (2012-2017). In terms of typology of projects, the different periods are quite heterogenous, regarding tools, methodologies there was also an clear evolution.

Table 1 summarizes the most important stages of development of the studio. Regarding the Form Language development during the several stages, as the projects grew on complexity, different methodologies and tools were added to the studio’s toolbox. We can argue that a more complex language was developed, particularly with the possibility of working in larger scale projects with experienced designers, advanced software and prototyping tools and new services such as the CMF. The project AlfaPendular illustrates this approach, as the designers developed the complete refurbishment of the high-speed train in Portugal, addressing not only the design project of different products (Halls, Seats, Toilets, Bar) as well as its color, material and finish, signage project, promotion media (renderings, videos), etcetera. This was also a reflection of all that was learned with previous projects in a combination of experience and new methodologies born from the innovation strategy devised in previous years.

Table 1 - Summary of literature review on Context: Almadesign Studio history

LITERATURE REVIEW: CONTEXT – ALMADESIGN STUDIO HISTORY				
Period	**Type of project**	**Designers**	**Methodologies / Tools**	**Results**
1997 - 2001	Transport, Product, Show, Communication	3 to 6 including the 3 founders	Research, Concept, Development, Production (during a short period), Prototype follow-up; A quality process was developed; software tools were used for 3d Modelling	In the beginning of the studio projects from different areas were accepted; a focus on transport but also product, show (Expo 98, Porto 2001) and communication (websites). The first award for the Enigma Bus is from this period.
2001 - 2007	Transport, Interiors, Product, Show, Communication	3 to 8	Research, Concept, Development, Prototype follow-up; software tools were used for concept design and 3d Modelling	A focus on Transport Design, Industrial machinery and Interiors was the focus of this period; Euro 2004 was the last project in show design; R&D strategy started to be developed towards the end of this period; different awards for vehicles and products
2007 - 2012	Transport, Interiors, Product, Communication	8 to 10	Research, Concept, Development, Prototyping, Prototype follow-up; software tools were used for prototyping, concept design and 3d Modelling; new research methodologies (structured brainstorming and moodboards)	A focus on the main areas but also on R&D projects in aviation, railway and automotive area; Alma nitec innovation lab was formed enabling the construction of scale prototypes at the studio; an innovation process was established; several awards including the Crystal Cabin Award 2012 for project LIFE
2012 - 2017	Transport, Product, Interiors	10 to 14	New Development methodologies (material Boards), CMF (color material and finish) services, Prototyping, Prototype follow-up; software tools were used for prototyping, concept design and 3d Modelling and visualization of whole interiors (such as trains and aviation)	A focus on the knowledge transfer between R&D projects and market products; CMF services were added in order to obtain a broader range of services form product design to brand language development; projects such as the Alfa Pendular and TAP aircraft became flag-ship projects for the studio;

(Source: researcher, 2017)

1.3 *Form Language in design history*

The main focus of this chapter is analyze Form Language in design history, reflecting Almadesign studio's designers preferences / references to visual culture and inspirational material. As reported in Experimental Study #2 (see Part III, Chapter 2), developed with studio's designers, a studio culture is built around its leadership and its designers with their own cultural references, preferences and visual culture. The Experimental study named "Box of Favorite Things" was developed with the main objectives to engage studio designers in the investigation by collecting a series of historical Design references chosen by each designer, which would reflect their personality, tastes, design education, visual culture (always referring to the Form Language theme). The results helped the researcher analyze the Form Language developed at the studio and establish bridges between the designer's own visual culture (and cultural background) and the studio's projects.

In this chapter we will look at the choices of the designers from a historical point of view, organized chronologically. These influences arise from both the designer's academic background as well as their personal experiences and popular culture where they have been immersed in. The chapter links these choices with an historical analysis of the industrial design profession, of the different Eras, technological and Form Language breakthroughs. In the search for the characterization of the Form Language of Almadesign, the following compilation of texts and visual references is a helpful guide in defining some of the most important historical periods of the design profession. Following a chronological approach, the information is organized in periods of fifty and twenty five years and includes texts and images by several designers, architects and historians.

Studio's designers were trained in many different schools such as the Scuola Politecnica de Design in Milan, Italy; Faculdade de Arquitectura da Universidade de Lisboa, in Lisbon; ESAD Matosinhos, Porto and Faculdade de Belas Artes, in Lisbon. These schools have different approaches towards design teaching, be them more art oriented, architectural or technical. With the founding partners of the studio being trained in Italy in the beginning of the 1990's, there was for sure a lot of influence from the Italian movements and from the Italian tradition in design and specifically in automotive, nautical and transport design. But as the Experimental Study reflected, designers share a lot of references from different areas such as Aeronautics, Sci-Fi, cinema, Architecture, Comics, etcetera. The journey through the Form Language which inspired studio designers also poses a lot of questions of how the industrial designers deal with different product dimensions (form, function, and technology) and how design is interconnected and related to the social fabric of its time.

1.3.1 1850 – 1900 First Machine Age

Horation Greenhough (1805-1852), a neoclassical sculptor, writer and critic, "argued that beauty in architecture and design was a result of fitness to function" (the industrial design reader, pp11). The author uses the comparision between "evolution" of biology and of design and was one of the first autohrs to state a doctrine of functionalism with a focus on observing nature:

> *"If, as the first step in our search after the great principles of construction, we but observe the skeletons and skins of animals, thorugh all the varieties of beast and bird, of fish and insect, are we not forcibly struck by their variety and their beauty? There is no arbitrary law of proportion, no unbended model of form (…) Beauty is the promise of fucntion" (The Travels, Observations and Experinence of a Yankee Stonecutter, New York: G.P, Putnam, 1852, APUD Industrial Design Reader);*

During Experimental Study 2,the studio's designers chose several nature imagery (as was asked by the researcher) such as the ones depicted in Figure 33, where form meets function and performance. The inner ear structure is an elegant example of minimal material use and clever geometry for best performance. The same can be said from animal world predators such as the cheetah, whose slim, long, lightwieght body outperforms all terrestrial animals in speed.

Figure 33 : Designer's choices for "nature" theme: inner ear structure and cheetah running
source: https://www.reference.com/science/definition-spongy-bone-f2d4762059ec86ba (accessed: Dez.2016)
http://pcwallart.com/cheetahs-running-full-speed-wallpaper-2.html *(accessed: Dez.2016)*

John Ruskin (1819-1900) was an art critic and professor of Fine Art and is considered one of the predecessors of the Arts and Crafts movement. In "The Stones of Venice", the author argues that "imperfect execution of ornament – as was often visible in gothic style – was an index of social conditions in which workers had freedom and dignity, whereas slick perfection in the execution of ornament – as in Victorian Britain – was a sign of social relations in which workers were enslaved and dehumanized". (Ruskin, apud Gorman, 2001, pp.11). The author links aestetics to the conditions of labor, one of the founding aspects of the Arts and Crafts movements, a reaction towards the fast pace of the industrial revolution. The problem arises between technological advancements –

Automation and perfection – and human capital. This was, of course, a theme further developed by Karl Marx (1818-1883), co-author of “Capital”, who argued that the use of machines did not intend to shorten or ease labor but to make goods more cheaply, with greater profit for the “master” instead of the worker. He argues:

> *“Like every other increase in the productiveness of labour, machinery is intended to cheapne commodities, and, by shortnening that portion of the working-day, in whihch the wiorkers works for himself, to lengthen the other portion that he gives, withou an equivalent, to the capitalist. In short, it is a means for producing surplus-value” and he goes on, referring to “Machinery, by throwing every member of that family on the labour market (refering to women and children) , spreads the value of the man’s labour power over his whole family” and goes on “The automaton (…) is therfore animated by the longing to reduce to a minimum the resistance offered by that repellant yet elatic natural barrier, man” (Marx, 1867, apud Gorman, 2001, pp. 23)*

On the aesthetics side, authors such as Christofer Dresser, botanist and designer, were looking at nature and referring to the economic value of beauty. He is considered one of the first industrial designers, having worked for different companies and promoting machine production rather than handicrafted products. He also refers to the respect towards material in the way products are designed. He argues:

> *“At the very outset we must recognise the fact that the beautiful has a comercial or money value (…) the material of which an object if formed should be used in a manner consistent with its own nature, and in that particular way in which it can be most easily “worked” (…) Proportion, like the curve, must be of a subtle nature (…) A principle of order must prevail in every ornamental composition (…) The orderly repetition of parts frequently aids in the production of ornamental effects (…) (Dresser, 1873, apud Gorman, 2001, pp 32)*

William Morris (1834-1896) designer, painter, poet, printer, entrepeneur, who is considered to have been a prominent socialist and theorist of the Arts and Crafts movement was a founder of the firm Morris & Co the goal of which was “to produce reasonably priced, well-designer furnishings, wallpapers, and textiles while employing skilled craftsmen at fair wages”. At the same time, Henry van de Velde (1963-1957) the Belgian Designer, Architect and Painter promoted the ideas of William Morris but expressed a wish to design for mass production. He is considered one of the fathers of the Art Nouveau style, and argues for “rational”, “honest” and “modern” forms suited to machine manufacture:

> *“We can succeed in modernizing the appearances of things by carrying out the simple intention to be strictly rational, by following the principle of rejection without exception all forms and ornamentation which a modern factory could not easily manufacture or reproduce, by plainly stating the essential structure of every piece of furniture and object and by constantly bearing in mind it must be easy to use” (van de Velde, 1897, apud Gorman, 2001, pp 47)*

The Thonet chairs (Figure 34) from the late 1800's were one of the choices from studio's designers as an example of a timeless, elegant, simple, industrialized product, optimized for its material and production technique.

Figure 34 : Designer's choices for "product design": 1880's Thonet "mass produced" chair
Source: https://www.treehugger.com/eco-friendly-furniture/the-chair-that-has-seated-millions.html (accessed: Dez. 2016)

1.3.2 1900 – 1950 Modernism

Frank Lloyd Wright (1867-1959) architect and designer had learned the craft with texts of John Ruskin and William Morris as references, however he opposes these two authors in their view of the relationship between design and technology, humans and machines. In a conference he addressed in 1901, he states that the Machine was "an integral part of modern society that had the potential to do great good, both socially and artistically" (Wright, 1901). He even plays with the words "Art and Craft" by arguing that the future of crafts was within the machine and that this was the pathway to development and democracy, by not focusing only on craftsmanship for a few very rich users. It is an interesting, progressive point of view, he argues:

> *(…) in the Machine lies the only future of art and craft – as I believe, a glorious future; that the Machine is, in fact, the metamorphosis of ancient art and craft; that we are at last face to face with the machine (…) Nor was it so grown as to become apparent to William Morris, the grand democrat, that the machine was the great forerunner of democracy (…) And, invincible, the machine goes on, gathering force and knitting the material necessities of mankind ever closer into a universal automatic fabric; the engine, the motor, and the battle-ship, the works of art of the century (…) Every age has done its work, produced its art with the best tools or contrivances it knew, the tools most successful, in saving the most precious thing in the world – human effort (…) The machine, by its wonderful cutting, shaping, smoothing, and repetitive capacity, has made it possible to so use it without waste that the poor as well as the rich may enjoy today beautiful surface treatments of clean, strong forms that the branch veneers of Sheraton and Chippendale only hinted at, with dire extravagance and which the middle ages utterly ignored" (Wright, 1901, apud Gorman, 2001, pp 55)*

The choices of the studio's designers included the architecture of Frank Lloyd Wright, specifically one of its landmark architectural houses, the falling water house. The architect was an extremelly talented draftsman and his approach to design with the use of simple geometrical themes (horizontal and vertical volumes), use of materials, color, lighting and natural finishes together with a seamless integration in the landscape were considered an influential work by studio's designers. (Figure 35).

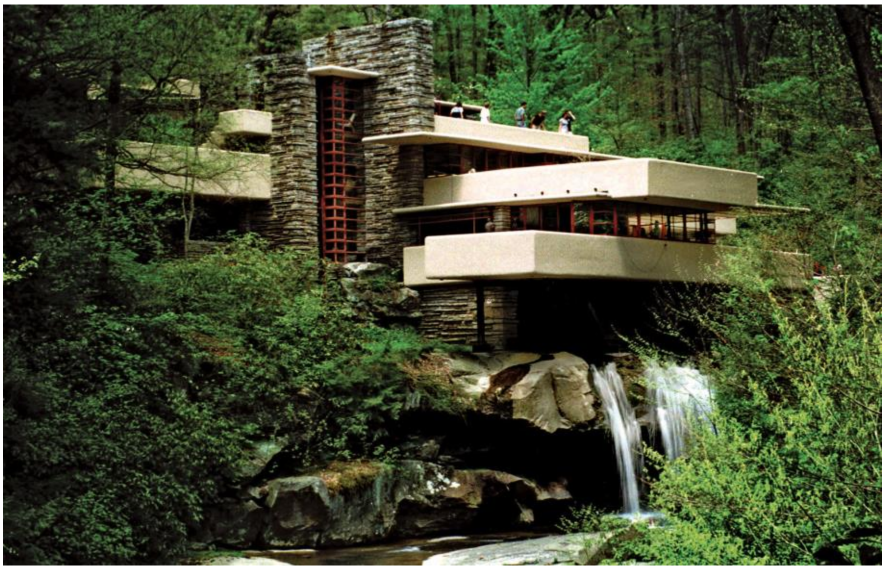


Figure 35 : Designer's choices for "architecture" theme: Frank Lloyd Wright's falling water
source: https://www.curbed.com/maps/glass-house-museum-historic-preservation-fallingwater (accessed: Dez.2016)

With a radical approach to the duality of "machine production" over "handcraft processes", the futurists exhibited a radical, fascist approach. Filippo Tommaso Marinneti (1876-1944) was one of the founders of the Futurism Manifesto, where the promotion of technological products such as the automobile, the aircraft, and their philosophical counterparts of speed, youth, masculinity and war was devised. The group sustained the great possibilities of technology for aesthetic and social progress. One of the designers and architects of the group, Antonio Sant'Elia is referenced as a conceptual architect in the way that he has no built work but could be compared with a sci-fi conceptual artist of his time, by promoting visionary ideas and future utopian worlds through design. In the radical Manifesto the authors, not without self-irony, state:

> *"(…) We say that the world's magnificence has been enriched by a new beauty; the beauty of speed. A racing car whose hood is adorned with great pipes, like serpents of explosive breath – a roaring car that seems to ride on grapeshot – is more beautiful than the Victory of Samothrace (..) Why should we look back, when what we want is to break down the mysterious doors of the Impossible? (…) We will glorify war – the world's only hygiene – militarism, patriotism, the destructive gesture of freedom-bringers, beautiful ideas worth doing for (…) We will destroy the museums, libraries, academies of every kind (…) The oldest of us is thirty: so we have at least a decade for finishing our work. When we are forty, other younger and stronger men will probably throw us in the wastebasket like useless manuscripts – we want it to happen!" (Marinetti, 1909, apud Gorman 2001, pp 70))*

With quite a different view, Walter Gropius (1883-1969), German Designer and Architect, director of the Bauhaus school in Weimar from 1919 to 1928, states (In the "Aims of the Bauhaus") the importance of crafts:

> *"The Bauhaus strives to bring together all creative effort into one whole, to reunify the disciplines of practical art – sculpture, painting, handicrafts, and the crafts – as inseparable components of a new architecture. The ultimate, if distant, aim of the Bauhaus is the unified work of art – the great structure – in which there is no disctinction between monumental and decorative art (…) Architects, painters, and sculptors are craftsmen in the true sence of the word; hence, a thorough training in the crafts, aquired in workshps and in Experimental studyal and practical sites, ir requiered of all students as the indespensable basis for all artistic production. (Walter Gropius, 1919, apud Gorman, 2001, pp 23)*

Theo van Doesburg, dutch painter, designer and architect was the founder of De Stijl, an avant-garde magazine, defended something of a different approach, a new style based on the "colaborative" work between man and machine which would lead to different results, to a new "mechanical aesthetic". He argues:

> *"The machine is all-important here: hand craftsmanship is appropriate to an individualistic view of life which has been overtaken by progress. Hand craftsmanship, in the age of materialistic philosophy, debased man to a machine; the machine, used properly in the service of cultural construction, is the only means of bringing about the concerse: social liberation (…) to serve artistic ends the use of machines must be governed by the artistic consciousness (…) The new potentialities of the machine have given rise to an esthetic theory appropraite to our age, which I have had the occasion to call the "mechanical aestethic"". (Doesburg, 1970, apud Gorman 2001, p. 102-103)*

The work of Piet Mondrian, one of the leaders of the De Stijl movement, has been influential for decades and has bee "copied","pasted" and reinterpreted in numerous industries such as fashion design. Fiigure 36 shows the use of Mondrian's work in a 60's Ives Saint Laurent collection, selected by studio designers (Figure 36):

Figure 36 : Designer's choices for "fashion" theme: Ives Saint Laurent "Mondrian collection", 1965
http://www.detodaforma.com/2015/03/mondrian-na-estetica-contemporanea.html (accessed: Dez. 2016)

Adolf Loos published a manifesto in 1910 (“Ormanent and crime”) which led to a school of though and often lead to misinterpretation, and standardization of architecture. The Mdernist architects would have a tremendous influence in the 20th century architecture but this movement eventually resulted in a standardized architecutre, heavily implemented in Europe after WWII. The choices of the studio’s designers feature the work of fundamental Modernist architects such as Mies Van der Rohe, depicted in the Pavillion in Barcelona (Figure 37). With its display of material qualities in simple forms (horizontal and vertical planes and columns) and a seamless connection between interior and exterior spaces, this pavillion was considered an exremelly influential work by studio designers.

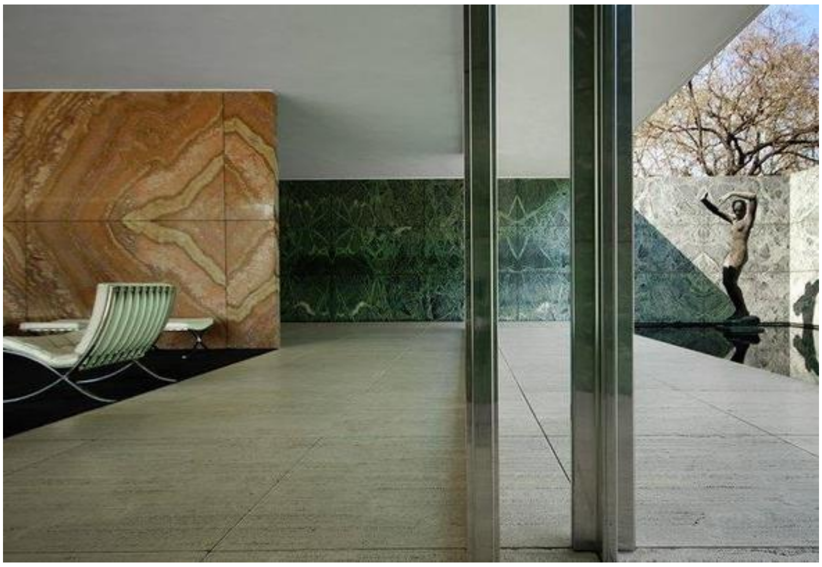


Figure 37 : Designer’s choices for “architecture” theme: Mies Van der Rohe Barcelona pavillion, 1929
http://www.midcenturyhome.com/barcelona-pavilion-mies-van-der-rohe/ (accessed: Dez.2016)

One of the highlights of the Modernist ideas were led by Le Corbusier, which brought an fundamental contribute to architecture and design, with the idea of developing standardization (and not diversity) to architecture. In the avant-garde houses he designed he claimed the concept of a “machine for living” and he wrote about product design and automobile design realting to the concept of standardization. He argues the following:

> *“The motor-car is an object with a simple function (to travel) and complicated aims (comfort, resistance, appearance), which has forced on big industry the absolute necessity of standardization. All motor-cars have the same essential arrangements. But, by reason of the unceasing competition between the inumerable firms who make them, every maker has found himself obliged to get to the top of this competition and, over and above the standard of practical realization, to prosecute the search for a perfection and a harmony beyond the mere practical side, a manifestation not only of perfection and harmony, but of beauty (…) Here we have the birth of style, that is to say the attainement, universilly recognize, of a state of perfection universally felt (…) Selection means rejection, pruning, cleansing; the clear and*

> *naked emergence of the Essential (…) Let us display , then, the Parthenon and the motor car so that it may be clear that it is a question of two products of selection in different fields, one of which has reached its climax and the other is evolving (…) Standardization is imposed by the law of selection and is an economic and social necessity. (Le Corbusier, 1927, apud Gorman, 2001, pp 106).*

It is interesting to note how an historical distance changes the perception on the work of modernist architects. Quoting Bjarke Ingels in his book Yes is More (2010), "Liberating the architectural vocabulary form stylistic exercises through the consistent elimination of excess ornament and redundant form, he (Mies van der Rohe) created a tabula rasa from which pure concepts and spaces could emerge". But the movement "gradually degenerated as the liberation mantra became a starvation of the imagination, turning the freedom from style into a stylistic straighjacket itself" (Ingels, 2010).

Not only in architecture but also in Industrial Design, it is interesting to look at the way standardization and mass production changed the market, the society and the design profession. A good example is the automotive industry. By the end of the 20's, Ford Model T was reaching its final production units, with more than 15 million units sold. The industrial design profession was starting to develop and, particularly interesting was the developing of the design work in the automotive industry, albeit few references in design theory and history. Markus Caspers (2016) in the book "Designing Motion - Automotive Designers, 1890 to 1990" argues:

> *"In Europe, from 1880, design was driven forward not only in practice, but also in theory. Starting with Ruskin and Morris, who understood the design of the living environment as an aesthetic fulfilment of a casual environment, via the vehement cultural criticism of Adol Loos, and the "less is more" maxim of functionalism, European design theory focused primarily on reduction, on the necessary as opposed to the superfluous. Associated with this approach was the underlying ideology of aesthetics as a formative instrument of modern, emancipated man, often combined with a criticism of capitalism – the impression that is evoked by the form tempts the buyer (…) According to this theory, the exchange value was identified as being immoral, since it was the use of value, that is, the long-term benefit to the consumer, which it should all be about. An additional onerous development for automotive design was the fact that the tendency towards reduction and rationality in the European design of the 1920's resulted in rectangular, cubist forms – heralding the death-knell for streamlined forms of objects that move fast through a medium. This meant that automotive design slipped out of the focus of design theory." (Caspers, 2016, p. 28)*

After Ford's huge success in the 20's, it would be General Motors to lead the way in terms of industrial design and the understanding of the need to segment the automotive market in order to reach out to different customers. The first styling departments, enabling the rise of the industrial design and automotive design profession would appear during the next decade:

> *"Alfred P. Sloan (1875-1966) became president of GM in 1923 (…) IN 1926, GM challenged its competitor, Ford, with a new model of its Chevrolet marque, the body of which imitated the styling of luxury class and which was available in numerous attractive colors. Ford found itself forced to extend its color range by two additional shades. Nevertheless, in 1927 the market share of the Model T had tumbled to 15 percent (from an incredible 52 percent in 1924). While GM had, by then, managed to achieve 45 percent. Sloan had intuitively understood that design is the aesthetic manifestation of sociocultural ideas; values such as contemporariness, modernity, advancement, speed, assertiveness, and so on could be portrayed and evoked by design. Harley Earl, who had dreamt of seeing his extravagant car bodies not only as one-off productions for wealthy customers but in series for all of America on the road, was in the same wavelength as Sloan." (Caspers, 2016, p. 22-27)*

But while automotive designers were understanding the way automotive design was the aesthetic and technical manifestation of a society and it culture, theorists were not looking at automotive design as a discipline. Albeit this, historians and architects were debating these questions in the US. An example is Art historian Alfred H. Barr, Jr and architect Philip Johnson who curated an exhibition at the Museum of Modern Art in New York in 1934, called "Machine Art", where industrial products were shown together with decorative arts from the "Machine Age". In this exhibition the beauty of functional, machine produced objects was put in to focus. The cultural understanding of physics and of the functionality of simple, striped down objects, devoid of other cultural references, historic references or decoration was underlined as the most beautiful object. They argued:

> "In addition to perfection of shape and rhythm, beauty of surface is an important aesthetic quality of machine art at its best. Perfection of surface is, of course, made possible by the refinement of modern materials and the precision of machine manufacture (…) The beauty in machine art as in all art varies in relation but not in proportion to its complexity (…) Moderately simple machine compositions such as (…) the ball bearing (…) prove more satisfactory (…) A knowledge of function may be of considerable important in the visual enjoyment of machine art (…) Whoever understands the dynamics of pitch in propeller blades (…) or the distribution of forces in a ball bearing (…) so that he can participate imaginatively in the action of mechanical functions is likely to find this knowledge enhances the beauty of objects." (MOMA "Machine Art", 1934, apud Gorman, 2001, p. 132-133)

Nevertheless, the automotive industry started to have a huge impact in culture in Europe and specially in the US, where great distances turned the automobille in the perfect fit for the countries mobility needs. The dymanics of movement, the science of aerodynamics and the booming aviation industry led to a movement, from the 30's, where a great influence was made by american designers: the "streamlining" movement. Burdek (1994) refers to this american movement as something where all kinds of objects were designed with aerodynamic lines, from automobiles, to radio transmitters, furniture, etcetera. influenced by the motor and aviation industry, and bringing the symbolic aspects of these technological objects to everyday products: symbol of modernity, progress and bright future. The americans, unlike the european, never argued against this kind of practice, where the consumer was put in the middle of the discussion, where aspirational objects were created with a symbolic meaning ahead of their functional meaning. Burdek explains:

> *"The technical dynamics of that Era found expression in the concept of speed. The automobile became the cult object par excellence, in the embodiment of the "American way of life" (Burdek, 1994, p. 110-112) 3*

American designers of this time, most of them coming from stage design, fashion design or advertising, were becoming important figures in the society of abundance and mass consuming market, being able to style products and bring new models very quickly in order to keep business "booming". They used "styling" as a tool to develop products which were well accepted in the market and which included complex assemblies and different technologies as a base, styled over and over to quickly refresh the product. Designers such as Raymond Loewy, Henry Dreyfuss, Walter Teague and Norman Bel Geddes were some of the main players of this age in which speed and technical features were the main driving expression of the times. This was also the time for the American car designers to gain importance in the industry. The first styling department was created in General Motors and the lead designer became a vice-president with power to propose new products, influence the company's strategy from marketing, production and engineering. The design in fact offered more than mere functionalism and had a huge marketing oriented influence, socio-semantic, helping Americans "climb the social ladder" and aspire to high-end products which all the big brands provided. The USA automotive designers can be seen as pioneers of industrial design and brand management:

> *"Aesthetically they (american designers) took their orientation from what, at the time, were the avant-garde technologies: nautics, aeronautics, and astronautics. Their creativity drew inspiration from actual aerodynamic research, but also from the pulp fiction magazines, which showed nuclear powered flying cars in front of each Californian bungalow. Status thinking and social advancement, as another aspect of mobility, began to influence (not only) automotive design. Alfred P. Sloan had developed a marque architecture for General Motors, presenting a low-priced starter marque with the Chevrolet (…) with the top model being the luxurious Cadillac. Just as the USA provided the social framework in which everybody could advance socially, so General Motors reflected the opportunities for advancement with its different products within one corporation. From the very beginning, the design incorporated a socio-semantic and marketing-driven component, which favored a different design philosophy from that of European functionalism." (Caspers, 2016, p.22-23)*

This streamlining Form Language, was also very much used in Europe, particularly after world war II. Norman Bel Geddes (1893-1958) was firstly famous by his design of stage sets (just as Henry Dreyfuss). He was a notable industrial designer that, like Buckminster Fuller, produced designs and visualizations for future products. He explains the fundamental aspects of streamlining, as it is used

[3] This author's translation

on a technical level for aircraft and automobiles. He argues that it is a scientific valid term, but which was used by advertising in a distorted way to sell products. He argues:

> *"Originally, the word "streamline" was a term of hydrodynamics, About the year 1909 the science of aerodynamics borrowed it to describe smooth flow of air as well as the form of a body which could move through the air with minimum resistance (…) copywriters seized upon it as a handy synonym for the word "new", using it indiscriminately and often inexactly to describe automobiles and women's dresses, railroad trains and men's shoes. Into such a general use has the word come that it is, perhaps, time to examine its meaning and its implications" (Bel Geddes, 1934, apud Gorman, 2001, pp135, 136).*

As with Henry Dreyfuss, Bel Geddes had the theatre and cinema sets as a "foundation" for the skills and craftmanship of an industrial designer, together with the technical understanding of the engineer. He goes on to explain the concept of streamling comparing aircraft design and car design:

> *"In spite of the hiatus here and there in the theory, parasite drag in the airplane has been eliminated to an amazing degree by the empirical methods (…) (but) has made little progress in the motor car, the railroad train, and the steamship, all of which stand to gain in efficeincy, riding confort, and economy when drag is reduced (…) streamlining of the motor car must reduce resistance to air (…) The first and simplest step is to reduce protuberances (…) Clean continous lines from front to rear would aid in reaching all the objectives (…) It is probable that this form will be a compromise, for it is extremely unlikely that any single solution can ideally satisfy all requirments (…) to provide convenience and comfort – two factors becoming increasingly important as the car (…) takes its place (…) as a normal commodity" (Norman Bel Geddes "Streamlining", Atlantic Monthly, Nov. 1934 APUD Industrial Design Reader, pp135, 136).*

Its during this time that the first design consultancies are created. Designers such as Raymond Lowey, Walter Teague or Norman Bel Geddes were asked to design and style hundreds of products. Burdek (1994) explains:

> *(…) This created the establishment on one side of technical complex products which had to be styled (many of the designers of the epoch were engineers in the first place, like Raymond Lowey, or Norman Bel geddes) but this also turned out to be the establishment of design as a tool to embilsh the surface of the objects and its shape which created a design totally submitted to the logical of the big corporation. A lot of these designers started out as engineers, than stage designers and the industrial designers, being able to "speak" the technical languge, but also to speak an artistic language concerned with user requirments, ergonomy, psycological factors, wishes and wants and the whole social ambiance of their times. They made their careers and professional successes by designing revolutionary ship interiors, aircraft interiors, automobiles, buses and trains (Burdek, 1994).[4]*

[4] this author's translation

We can argue that Almadesign was born in the tradition of such design consultancies, first starting in the USA with roots of product and transport design. This seems to be very much the birth of the idea of a design consultancy, considering the designer not as a specialist but as a generalist, who has some technical knowledge but who brings a fresh view and cross-polination knowledge from other industries (clients), hopefully improving the sales of a product.

> *"He (the designer) brings to his client a broader design point of view than a man can have when burdened with the responsabilities of everyday operation. He fully acknowledges the superior technical knowledge of the men in the client's organization (…) But, through his varied contacts, he may contribute a helpful knowledge of materials and methods gained in the plants of other clients (…) And the business man who realizes the importance of design and knows how to get the best value for his design expenditure is, other things being equal, the man who sells the most products" (Van Doren, 1940, apud Gorman, 2001, pp142-144)*

With the rise of the industrial design profession, and with so many products and artifacts to produce, eventually an exhibition on the work on the "new" generation of designers was developed. In 1941 Eliot Noyes (1910-1977) organized a furniture design competition, as a curator of the MOMA. The winners of the conpetition included Charles and Ray Eames and Eero Saarinen whose work was part of the exhibition named "Organic Design in Home Furnishings" in which some of the most iconic 20th century pieces of furniture are included.

> "The wonders of modern mechanism, we all know, have wrought much more than a change in our habits of life. Economis and politics and the fate of nations in war and peace are all affected by the vast recent changes in the equipment of man (…) In provate, at home, most of us still live in the clutter of inheritance forn the nineteenth century (…) (Noyes, 1941, apud Gorman, 2001, p.145)

Noyes refers specifically to furniture developed by Saarinen and the Eames, focusing on the development of a new technique of building furniture using laminated wood veneer for lightweight, laminar strcutures. This was a process firstly used by the Eames in order to produce objects for injured soldiers of the II World War.

> *"A significant innovation was that, in the case of chairs by Saarinen and Eames, a manufacturing method never previously applied to furniture was employed to make a light structural sheel consisting of layers of plastic glue and wood veneer molded in three dimensional forms."* (Noyes, 1941, apud Gorman, 2001, p.146)

The choices of the studio's designers feature the work of Arne Jacobsen, in his chairs from the 50's. Considered to be confortable, organic and ergonomic design, the studio's designers claimed this products as fundamental influences in their work. The following image (Figure 38) depicts some of the studio designers' choices:

Figure 38 : Designer's choices for "product design" theme: Arne Jacobsen's chairs from the 50's
Source: http://nationofdesign.com/da/90-miniaturer (accessed: Dez 2016)

In the 50's, designer Harley Earl was the true pioneer in GM, becoming the first Design director and also the first to set up a Advanced Styling Department capable of producing visionary prototypes and tour them around the country in the famous GM Motorama trade show fairs. But the continous move into new products and new design every year (the theory of "planned obsolescence"), together with the end of the economic boom of the 50's and the rise of safety issues in american car industry led to reaction both in the automotive industry – where the fins and decorative chrome reached its epitome in the year Harley Earl left, 1959 – and the design field in europe and the USA. Car design became more understated, safety issues were tackled with greater care and a reaction in the design theory was materialized in the words of designer Max Bill.

> *(…) to counter this practice (planned obsolescence) with what was referred to as "Die gute Form" (the good form) – a functional and reliable creation of objects, using genuine materials and representing value for money, with "honest forms that are never used in the context of sales propaganda" and would not have that reprehensible "rapidly changing, fashionable appearance" as the Swiss designer, Max Bill, wrote about it in 1952. "Die gute Form" was sensible, functional, ergonomically optimized, hygienically impeccable, efficient; it was not oriented towards the consumer and his pleasure in using it, which always also includes a symbolic component. Therefore, design following this principle could not be used for social differentiation – it even opposed to it. But contrary to what was planned, it was not devoid of a social function, because the pricey electrical equipment by Braun could and would only be afforded by a small elite who understood the simplicity of the form as an aesthetic*

characteristic of its superior taste compared with the "common" people. The simple, tidy, ornament-free became an aesthetic symbol of the expensive, long-lasting, intellectual." (Caspers, 2016, p.29)

In 1950 Edgar Kaufmann, jr, curator at the MOMA, organized the exhibitions "Good Design" in which he defended the principles of Modern Style in design. He argues:

"(from the twelve princples of Modern Design) (…) Modern design should express the methods used to make an object, not disguising mass production as handicraft or simulating a technique not used (…) Modern design should blend the expression of utility, materials and process into a visually satisfactory whole (…) modern design should master the machine for the service of man (…) Modern design should serve as wide public as possible, considering modest needs and limited costs no less challenging that the requierments of pomp and luxury (…) Daring or conservative, modern design embodies the values of our age, based on democracy and industrialization; designers seek to express these values thoruh that direct blend of efficiency and beauty which in any age characterizes good design (…) a thourough merging of form and function, and an awareness of human values expressed in relation to industrial production for a democratic society" (Kaufmann, 1950, apud Gorman, 2001, p.147-150

Interestingly enough, the work of Charles and Ray Eames completely integrates all these mentioned principles but manages to somehow intepret the Modernist movement in a slightly different way, with an introduction of scultural, aesthetic extraordinary pieces, which carry layers of signs and simbolic references. The designers were able to design such products and pioneer the use of composite materials such as polister reinforced fiber glass or bent, pressed plywood, which they helped develop into expressive, functional and sculptural furniture design (Figure 39).

Figure 39 : Designer's choices for "product" and "architecture": 1950's Eames' furniture and house
Source: http://living.corriere.it/arredamento/soggiorno/vitra-corner-larinascente-milano-402078431829/?refresh_ce-cp
http://www.fernandomayer.cl/producto/eames-lounge-chair-ottoman/ (accessed: Dez.2016)

1.3.3 1950 – 1975 The jet age

This is the golden age of American car design. After World War Two, a lot of designers and engineers having worked in the aviation military industry turned into automotive design and development. A booming US economy and the Marshall plan for rebuilding Europe set the conditions for a decade (the 50's) in which an economic surge would result in the proliferation of designs and industrial designers:

> *World War Two had stopped automobile development (…) switched over to military operations (….) Many designers and construction companies now worked in aircraft development. Following the end of the war, this was to have an aesthetic effect on automotive design (…) this shows the strange fascination many automobile designers had for a leading technology, which in essence was really a destruction technology – but, until the beginning of space travel, aviation remained without any doubt the most highly developed technology in transportation (…) Science-fiction fantasies about jet-powered airplanes, which would one day be able to fly into space, inspired American design in particular. Not only were tailfins added to the rear of cars, but the front bumpers were shaped in the form of the conical heads of rockets and GM tried to develop a hybrid of the automobile and the jet plane with its Firebird studies (Caspers, 2016, p.56)*

The choice for "transport" design from the studio's designers reflect this era, with specific references to American car design and models such as the Corvette Stingray, associated with speed and an "organic" look and feel (the name "stingray" is a direct analogy but the side air vents can be traced to sharks) depicted in Figure 40.

Figure 40 : Designer's choices for "transport design" theme: GM's Corvette Stingray, 1959
http://www.hotrod.com/articles/top-10-crazy-corvette-customs-from-yesteryear/ (accessed: Dez. 2016)

Raymond Loewy (1893-1986) was a renowned industrial designer working in the USA. For 50 years, designing Greyhound Buses, Coke bottles, agricultural machines, space labs for NASA, for some of the largest companies in the world (Gorman, 2001). He is one of the founding fathers of the Design Consultancy (or design studio) elevating the role of the designer as a consultant for big manufacturing companies. Regarding clients and user's preferences, Lowey argued that there is a balance between novelty and "shocking zone" in which one has to be attentive and focused on in order to bring successful product to market. He straight forward defended that "beautiful products sell", and was a champion at market understanding and consumer psychological response to products. He argued:

> *"There seems to be for each individual product (service, or store or package, etc) a critical area at which the consumer's desire for novelty reaches what I might call the sock-zone. At that point the urge to buy reaches a plateau, and sometimes evolves into a resistance to buying (…) the smart industrial designer (…) has a lucid understanding of where the shock zone lies (…) At this point, a design has reached what I call the MAYA (Most Advanced Yet Acceptable) stage" (Lowey, 1951, apud Gorman, 2001, p.155).*

He goes on to discuss that there is a "standard" look for something when a big company establishes and sells a product for some time, which influences consumer response:

> *"Mass production of a successful given product by a powerful company over a period of time tends to establish the appearance of this particular item as the norm in its own field (the public more or less accepts it as the standard for "look" or styling) (…) Any new design that departs abruptly form this norm involves a variable risk to the manufacturer (…) The risk increases (…) (with) the design gap between norm and advanced model (…) The consumer is influenced in his choice of styling by two opposing factors: (a) attraction to the new and (b) resistance to the unfamiliar (…) if the design seems too radical for the consumer, he resists it whether the design is a masterpiece or not" (Lowey, 1951, apud Gorman, 2001 p.156, 157).*

In 1955 Henry Dreyfuss (1904-1972) published "Designing for people". Henry Dreyfuss started as a stage designer and became one of the top consultancies in the USA, designing cruiseline interiors, aircraft cabin interiors and all kinds of products and industrial machinery. He was also one of the fathers of the field of Ergonomics (which he named Human Engineering). He gathered data from anthropometric measures, but also about strength, odour, temperature and all kinds of physiological and psychological factors that affect a user in his environment and made a systematic approach to this information to design products which would "make man and woman compatible to their environment". He calls them "Joe" and "Josephine":

> *"Our job is to make Joe and Josephine compatible with their environment. The process is known as human engineering (…) Colour can make Joe and Josephine gay or sad (…) Sound*

bombards Joe and Josephine form all directions (…) (they) are affected by odours (…) From all this, it is apparent that the industrial designer's task is twofold – to fit the client's wares to Joe's and Josephine's anatomies, and to explore their psychology and try to lessen the mental strains of this pressure age. It is not enough to sit them comfortably at their work. There is a responsibility also to remove the factors that (…) cause headaches, backaches, fatigue, and give them a feeling of insecurity" (Dreyfuss, 1955, p. 26-31)

In 1953 the "Ulm School of Design" began teaching design, championing an aesthetic of spare elegance and functionalism, with a lasting impact on particularly the field of electronics (Gorman, 2001). Max Bill, having studied at the Bauhaus, structured the curriculum focused on a modernist approach or functionalist approach. Small cars were being designed and developed in Europe using a clearly functional approach, such as the case with the Mini which presented a new architecture with its front transversal engine, small wheels on ends of the body work and big interior space. These small cars were perfect for the post-WWII mobility necessities of European cities, with small streets. The choice of different studio's designers, the MINI was considered "iconic", "Utilitarian" in a "cute" package (Figure 41). The functional approach, nevertheless, became a sociocultural icon and phenomenon.

Figure 41 : Designer's choice for "transport design" theme: Alec Issigonis's BMC Mini, 1959
Source: https://classicdriverbrasil.wordpress.com/2011/03/26/mini/ (accessed: Dez.2016)

At the same time in the USA, architects were building "futuristic" buildings inspired by the jet-age and nature elements, such as the TWA Terminal in JFK Airport in New York city. One of the choices of the studio's designers for the "architecture theme", the building features a wing shaped roof overviewing the runway, with and interior design based on fluid organic shapes, tubed shaped corridors to access the boarding gates and integrated furniture in the buildings' architecture. Futuristic elements, a seamless blend of form, function and sculptural nature shaped elements create a striking architectural experience (Figure 42). This "futuristic" architecture seems to carry a lot of industrial design references as it is normally associated with styling elements in products, and these are probably the roots of architect inspiration for contemporary buildings such as the work of

Santiago Calatrava or Zaha Hadid, highly mentioned and appreciated in the studio's culture, as they appear as references in numerous moodboards for inspiration.

Figure 42 : Designer's choices for "architecture" theme: Eero Saarinen's TWA Terminal at JFK
Source: https://www.archdaily.com.br/br/01-76775/classicos-da-arquitetura-twa-terminal-eero-saarinen
(accessed: Dez.2016)

In Europe, we could see both sides of the story. With opposing design and Form Language philosophies, Dieter Rams and Verner Panton were creating separate and maybe even opposite approaches. The Panton chair, the first chair to be mass produced using only one operation (injection moulded) captures the spirit of the sixties in a human oriented, ergonomic colored shape. On the other ende, Dieter rams was leading the "good design movement" and creating memorable functional products for Braun, which are an inspiration to generations of designers (including, of course, Apple's Jonathan Ive). Both Rams and Panton was chosen by the studio's designers, albeit with a larger preference for the choice of Ram's products (Figures 43 and 44).

Figure 43 : Designer's choices for "product": 1958 Dieter Rams' Radio & Record Player for Braun
Source: https://justgoodthemes.eu/forma-pro-v2/page/2/) (Accessed: Dez.2016)

Figure 44 : Designer's choices for "product" theme: Verner Panton's 1 piece plastic chair from 1960
Source: https://befrontmag.com/2016/09/05/10-timeless-chairs-that-changed-our-lives/ (Accessed: Dez.2016)

This decade also saw the birth of environmental groups and in 1969, together with other concepts of environmentalism (the year man saw the earth as a finite planet from the moon) R. Buckminster Fuller wrote "Operating Manual for Spaceship Earth". Heavily influenced by the moon race, but also by a feeling of the extreme use of resources from the planet, Fuller "emphasizes the need to conserve the earth's resources" – a message that was forcefully pushed into American houses during the energy crisis of the 1970's and the surging gas prices. Buckminster Fuller work on low-cost, mass produced, transportable solutions to housing problems which were not commercially successful. His geodesic dome structures, enclosed a maximum volume with a very small surface area and building material, were famous in the Expo 67 in Montreal in the USA pavilion, communicating ideas about environment and sustainability. In his metaphor for the "spaceship earth" he argues:

> *"We have discovered that it is highly feasible for all human passengers aboard Spaceship Earth to enjoy the whole ship (…) provided that we are not so foolish as to burn up our ship and its reactor generated energy" (Fuller, 1969, apud Gorman, 2001, p.186-187).*

The 1970's oil crisis, world conferences on environmental issues and books published such as the 1972 "Limits to growth" pushed the theme of the finite resources into the table and posed different challenges to the industrial designer which the profession tried to respond in the next few years. USA president Richard Nixon addressed the nation in November 1973, stating that "Now, our growing demands have bumped up against the limits of available supply, and until we provide new sources of energy for tomorrow, we must be prepared to tighten our belts today." (Nixon, 1971). Automotive design was clearly influenced at this stage by the technological possibilities presented by the man getting to the moon. Italian designers and external design studios had their most prolific moments during this time, with companies such as Bertone, Pininfarina, Ghia, Touring and designers such as

Giugiaro, Gandhini, Michelotti and Frua becoming the major players for European automotive design. The Pininfarina Modulo is an example of a prototype car developed by an “external design studio” in Italy, having captured the minds of designers for decades with its Sci-fi look and feel. This was one of the choices of the studio’s designers and it is depicted in Figure 45.

Figure 45 : Designer’s choices for “transport” theme: 1970 Ferrari Modulo, designer Paolo Martin
Source: http://maxcars.biz/ferrari-modulo/ (Accessed: Dez.2016)

Victor Papanek wrote “Design for the Real World” in 1971 on the verge of the oil crisis. As a professional he is very critical of the role of the industrial designer in the use of resources and in the capitalist economy, referring to patents and systems of keeping knowledge as distortions of the real functional of the industrial designer. He argues the designers are a “dangerous breed” and that a social a ethical responsibility should be part of each designer as he is one of the main responsible for mass production objects which affect millions of people. He argues:

> *“There are professions more harmful than industrial design, but only a very few of them (…) By designing criminally unsafe automobiles that kill or maim nearly one million people around the world each year, by creating whole new species of permanent garbage to clutter up the landscape, and by choosing materials and processes that pollute the air we breathe, designers have become a dangerous breed. And the skills needed in these activities are taught carefully to young people (…) In an age of mass production when everything must be planned and designed, design has become the most powerful tool with which man shapes his tools and environment (and by extension, society and himself). This demands high social and moral responsibility form the designer. (Papanek, 1971, p.ix)*

The author is also very critical on the modernist approach – in terms of standardization and machine made products - referring to Le Corbusiers “machine à habiter” as “reflecting a perversion of aesthetics and utility”. But at the same time, a marvel of technology appeared, the Concorde which influenced a whole generation of designers and engineers. But architecture, design and engineering presented a huge, diverse form culture at this time. An example is the choice of the studio’s designers for the "architecture theme" in which the Sydney Opera House by Danish architect Jorn Utzon is an example of an reinterpretation of a classical architectural typology "a Scandinavian interpretation of a Chinese typology – the pagoda on a plinth (Ingels, 2010) with clear analogies to natural elements (Figure 46).

Figure 46 : Designer's choices for "architecture" theme: Utzon's Sydney Opera House, from 1973
Source: https://humuscreativity.wordpress.com/utzon/ (Accessed: Dez.2016)

It is in the 70's that the first (and still only…) supersonic commercial aircraft was tested and flown. Concorde was a joint effort between France and the UK and brought air transport at twice the speed of sound to operation. Both the US and USSR had similar projects but only the European flew for over 25 years. This was one of the chosen projects by studio designers in its depiction of fast high-tech transport made available in an optimistic technological era (Figure 47).

Figure 47 : Designer's choices for "Transport" theme: supersonic Concorde, operated form 1976-2003
Source: https://amuseum.cdstm.cn/AMuseum/hangkong/sjmj_ysj_24.html (Accessed: Dez. 2016)

1.3.4 1975 - 2000 – Post Modernism

In 1966 Robert Venturi an American architect and designer published "Complexity and Contradiction in Architecture", where he argued for an architecture that privileged "messy vitality over obvious unity". Together with the so-called post-modernist architects, had an impact on industrial design during the 1980's. He argued:

> *"I like elements which are hybrid rather than "pure", compromising rather than "clean" (…) ambiguous rather than "articulated" (…) "redundant" rather than simple (…) inconsistent and equivocal rather than direct and clear. I am for messy vitality over obvious unity (…) I am for richness of meaning rather than clarity of meaning; for the implicit function as well as the explicit function (…) A valid architecture evokes many levels of meaning and combinations of focus: its space and its elements become readable and workable in several ways at once." (Venturi, 1966, apud Gorman 2001, pp.184-185).*

Robert Venturi had a longing influence on design groups such as Memphis, many Italian designers and also the French Phillipe stark, which had an important rolein the way products were developed and produced in the 80's and 90's. But this designer and architect "counterrevolution"n against modernism and functional architecture "in turn led to its own epidemic of indistinguishable Postmodern towers no more varied nor interesting than their Modern siblings" (Ingels, 2010). In 1984 Klaus Krippendorf and Reihart Butter published "Product Semantics: Exploring the Symbolic Qualities of Form" in Innovation magazine. Their theory comes at a time where mass production, globalization and personal computers are coming into the scene as well as post-modernist theory and practice. They are both German-American and both studied at the Ulm School of design, arguing about the importance of Product Semantics:

> *"In its broader sense, design is the conscious creation of forms to serve human needs (…) Probably the most noteworthy development in design today (…) is its concern for the cognitive meanings, symbolic functions and cultural histories of form. We can trace this concern to developments in Ulm some 25 years ago which are now coming to fruition by the name of "product semantics". Product semantics is the study if the symbolic qualities of man-made forms in the context of their use and the application of this knowledge to industrial design. It takes into account not only the physical and physiological functions, but the psychological, social and cultural context, which we call the symbolic environment (…) through product semantics, designers can demystify complex technology, improve the interaction between artefacts and their users and enhance opportunities for self-expression." (Krippendorf and Butter, 1984).*

Worried about new technologies and new objects emerging (computers, user interfaces, etc) and the need to use metaphors and strategies to better communicate the technologies and the new objects (such as the famous "desktop" metaphor in user interfaces with computers) the authors also noted that there is a complex non-linear communication path between designer and user. They argue:

> *"The knowledge product semantics provides about how objects work within the context of their use cannot entirely be expressed in terms of linear communication between a designer and a user. The crucial difference lies in the individuality of the users' interpretations which evolve in the circular process of their involvement with the designers products. (Krippendorf and Butter, 1984).*

The personal computer age, beginning in the 70's with Steve Jobs and Steve Wozniak from Apple, was accompanied by a generation of successful movie makers from the "baby boom" generation in the USA: Steven Spielberg, George Lucas, Ridley Scott. Movies such as Star Wars, Alien or Blade Runner all used industrial designer's expertise to help build Sci-fi worlds which have had a big influence in the studio's designers. It is not a surprise that some of these movies were chosen as a particularly important reference to the studio's designers (Figure 48 and 49) as the directors used industrial designers to create future worlds. Designers (and futurists) such as Ralph McQuarrie, Syd Mead or H.R. Giger all had a great influence in the Form Language depicted in these movies, which would influence the visual culture of the next decades, particularly artists, designers and architects. Another reference mentioned by the designers is from comics and animation, particularly the French-Belgian cartoon artists such as Enki Bilal, Jean Moebius (Figure 50) and Japanese anime authors such as Hayao Miyazaki and Mamoru Oshii. The designer's choices for Comics and Animation ranged from Post Apocalyptic "Future Boy Conan" to "Ghost in the Shell" which is one of the creative works referring to artificial intelligence and cyberspace, terms which were also developed in William Gibson's cyberpunk novels such as Neuromancer in 1984 (the cyberspace theme and AI would be later developed in blockbuster movies such as The Matrix).

Figure 48 : Designer's choices for "Movie" theme: George Lucas's Star Wars from 1977
Source: http://thecapeandcowl.blogspot.pt/2015/11/official-star-wars-galaxy-map-updates.html (Accessed: Dez.2016)

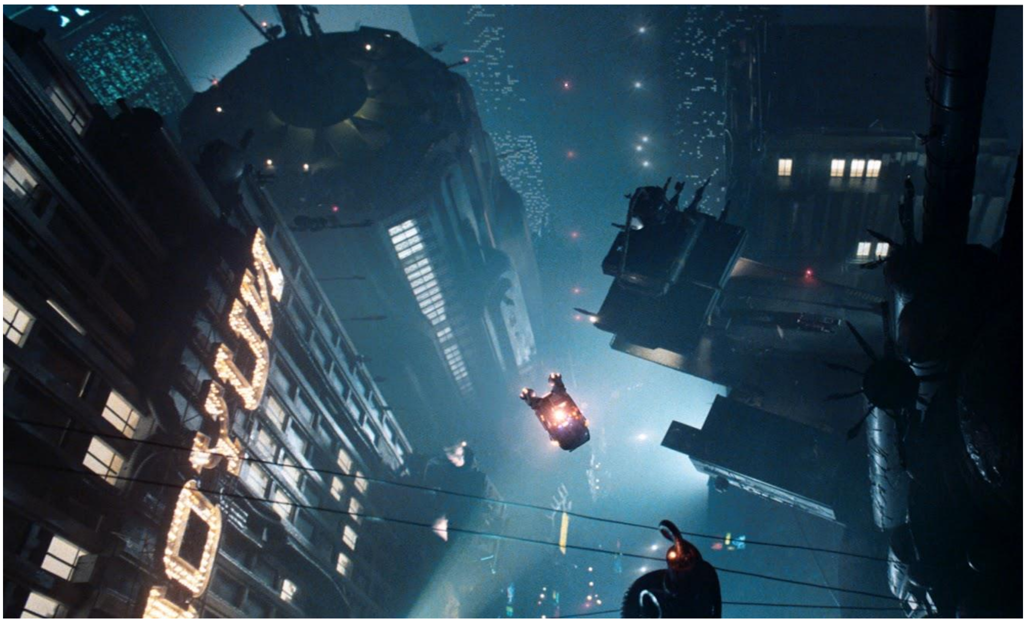


Figure 49 : Designer's choices for "Movie" theme: Ridley Scott neo-noir sci-fi Blade Runner from 1982
Source: https://www.filmaffinity.com/es/movieimage.php?imageId=237438038 (Accessed: Dez. 2016)

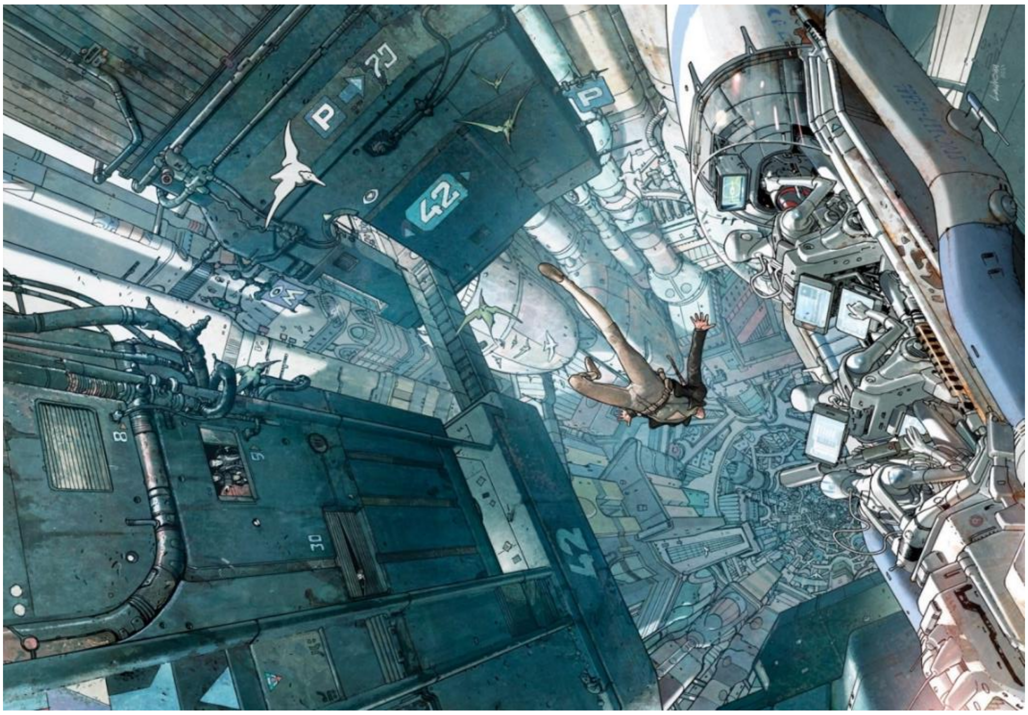


Figure 50 : Designer's choices for "Comics/Animation" theme: 80's Moebius and Jodorowski comics
Source: http://www.teleport.mx/resenas/comics-resenas/jodorowsky-trabajos-imperdibles-comic/ (Accessed: Dez.2016)

In 1984, Italian critic Barbara Radice wrote about the Memphis Group experience. Memphis was founded in Milan in 1981 by Ettore Sottsass, challenging modernist principles. Just like the texts of Robert Venturi, the group wanted a change in the dominant way of designing, referring to popular culture references and promoting radical change rather than established principles. She argues:

> *“Memphis never feared fashion, being a fashion or going out of fashion. On the contrary, it foresaw and adjusted from the outset to this fluid state of variability. I quote form my introduction to the catalogue, the statement that perhaps caused the greatest uproar at the time of presentation in 1981: “We are all sure that Memphis furniture will soon go out of style” (…) (Barbara Radice, Memphis: Research, Experience, Results, Failures, and Sucesses of New Design (New York, Rizzoli, 1984; APUD The industrial design reader p.204)*

She goes on to argue by quoting Sotsass that “Today everything one does is consumed. It is dedicated to life, not to eternity” meaning that the work of Memphis was based on the present, contemporary culture and consumption (Radice, 1984). She also refers to the “hidden” wishes of the consumer, as opposed to what the consumers “think they need”. She argues a focus on appearance rather than content, of something passing by and fading away to be replaced by newer things (just like the futurist manifesto argued) even mentioning the nuclear “end” as the destiny of humankind:

> *“Memphis does no claim to know what people “need”, but it runs the risk of guessing what people “want” (…) Memphis objects, by emptying themselves of meaning and charging themselves with enigma, go back to being ritual objects, propitiatory diagrams, and ceremonial formulas. They offer life, not an explanation but a sense, arbitrary as it may be; the sense of life in self-contemplation (…) Memphis, like fashion, works on the fabric of contemporaneity, and contemporaneity means computers, electronics, videogames, science-fiction comics, Blade Runner, Space Shuttle, biogenetics, laser bombs, a new awareness of the body, exotic diets and banquets, mass exercise and tourism. Mobility is perhaps the most macroscopic novelty of this culture (…) What matters to us is not their substance but their appearance, their virtual image (…) concerned with self-destruction, annihilation, disappearance, which is also the magic formula of our destiny, of life which in order to glitter must fade and liberate, as radioactive fallout, the shivers and omens of the end.” (Radice, 1984, apud Gorman 2001, p.205,206)*

Charles Jencks helped popularize the term Post-Modernism in 1977. In his evolving text “What is post-modernism” he argues for the case of fragmented cultures in a globalized world. It is the first years of the rise of the Internet and the author starts discussion themes of decentralization and peripheral decision making. His concepts also eco the idea of “mass customization” where the consumer can have a role in the production of a mass product specifically customized for him. He argues:

“There is a partial shift form mass-production to segmented production (from Fordism to Post-Fordism); the slide from a relatively integrated mass-culture to many fragmented taste cultures (minoritisation); from centralised control in government and business to peripheral decision making; form repetitive manufacture of identical objects to fast-changing manufacture of varying objects; from few styles to many genres; from national identification to both local and global consciousness” (Jenks, 1996, apud Gorman 2001, pp223-224)

In 1988, C. Thomas Mitchell, director of the research lab Center for Design process, argues for the creation of “new, post-industrial design methods” focusing on experiences rather than on the physicality of products themselves (Gorman, 2001). His essay *“Design after Modernism: Beyond the Object”* illustrates the fast-growing integration of personal computers in everyday life, workplace and in house, and software designers as the creators of a new paradigm. He introduces the concept of co-designing, in which the user is also participating by using the software as a tool to create something. The shift towards user-experience ad service design had started:

“By creating systems which focus upon people’s experience of using their product, rather than upon the physicality of the product itself, software makers have created new roles for themselves. Like the avant-garde artists, software makers assume the passive role of providing systems in which everyone may participate. Unlike traditional product design, which is intended solely as a means of producing physical objects, post-industrial designing, as typified by the software making, is a continuous and non-instrumental thought process participated in equally by software makers and users (…) The designer’s role in the post-mechanical era is to make the design process equally accessible to everyone. In order to realize this programme, design, like the avant-garde art before it, must abandon aesthetics and become instead a socially oriented process in which, like the new scientists, we are all both spectators and actors. (Mitchell, 1984, apud Gorman 2001, p. 214)

1.3.5 2000 – 2025 Industry 4.0

We have reached the turn of the century, the time Almadesign was funded (1997). In its 20 years of activity we have seen the commoditization of the cellular phone, portable computers, the appearance of the Smart Phone, of the Tablet. We have seen Internet rising as main information and communication resource, with “all the knowledge of the world” available at the touch of a screen. Social media, new software tools, the rise of automation, electrification, changes in ownership, peer economies and co-creation culture: Industry 4.0 or the second machine age is on its way. Companies like Google, Facebook, Instagram, Amazon, Uber or Tesla appeared in the last 10 to 20 years and there are among the most valuable the world. Klaus Schwab from the World Economic Forum argues:

> *“The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres” (Schwab, 2016)*

The role of the industrial designer in a more and more digitalized world is a question mark. From the latest years, designers at the studio reference different kinds of projects, which enable us to have a glimpse of what is happening. In the automotive design theme, the BMW Gina was a landmark design, featuring a shape shifting morphing skin over a lightweight structure. (Figure 51).

Figure 51 : Designer’s choices for “Automotive” theme: BMW Gina concept from 2001
Source: http://www.topcars.bg/news.php?id=317 (Accessed: Dez.2016)

In aviation design the rise of the industrial designer as a “cabin designer” for airlines has been gaining momentum for the last 15 years. The huge increase in passenger transport, the rapid development of low cost carriers and the surge of new aircraft manufacturers, particularly in Japan and China, created a booming sector which is growing steadily. Airlines need to make clear branding statements and designers “enter the scene”. Some of the most interesting projects came up from Boeing, the company that presented the 787 dreamliner with the innovative “sky” interior. This was one of the choices from studio’s designers and it is depicted in figure 52.

Figure 52 : Designer’s choices for “Transport”: Teague’s Boeing 787 interior from 2004 *http://www.liligo.it/magazine-viaggiatore/aerei-design-degli-interni-anche-locchio-vuole-la-sua-parte-726.html (Accessed: Dez.2016)*

Regarding architecture, the so called “Parametricism” (Figure 53), particularly in the work of Zaha Hadid architects has been seen as a great influence for designers, specifically industrial designers and transport designers. Their approach employs different techniques of animation, form finding, parametric modelling and scripting in order to get to a design solution. Complex and unconventional, it has had an aesthetic influence over designers as a whole and for Almadesign designers specifically. Patrick Schumacher, main theorist from Zaha Hadid architects explains:

> *“Parametricism emerges from the creative exploitation of parametric design systems in view of articulating increasingly complex social processes and institutions. The parametric design tools themselves cannot account for this profound shift in style from modernism to parametricism. This is evidenced by the fact that late modernist architects are employing parametric tools in ways which result in the maintenance of a modernist aesthetics, i.e. using parametric modelling to inconspicuously absorb complexity. The parametricist sensibility*

pushes in the opposite direction and aims for a maximal emphasis on conspicuous differentiation and the visual amplification differentiating logics. Aesthetically it is the elegance4 of ordered complexity and the sense of seamless fluidity, akin to natural systems, that is the hallmark of parametricism" (Schumacher, 2012)

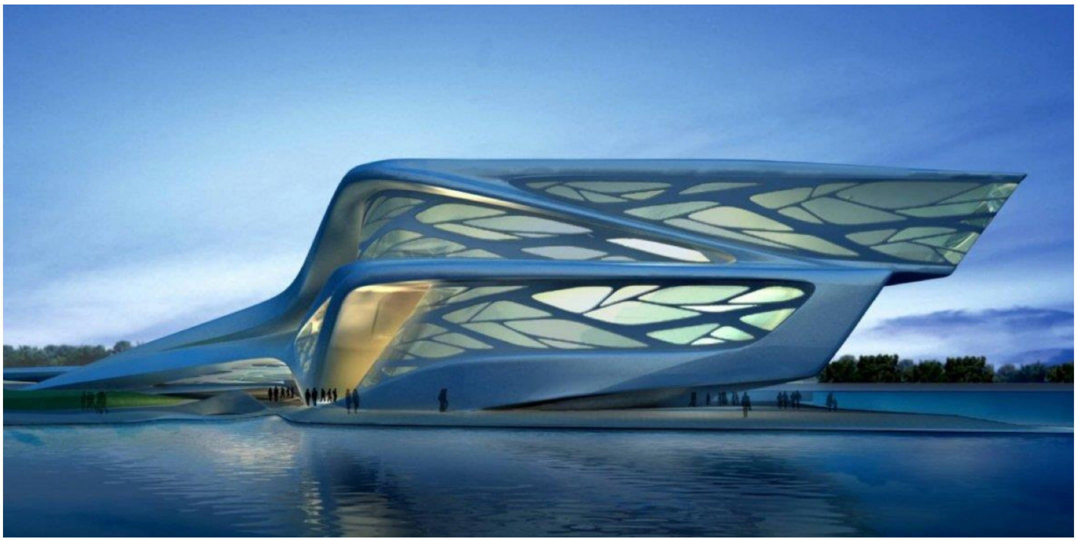


Figure 53 : Designer's choices for "Architecture: 2007 Zaha Hadid Abu Dhabi Performing Arts Centre
Source: http://artpil.com/zaha-hadid/ (Accessed: Dez.2016)

The use of creative tools and computer software for an hybridization of architecture does not only take into account the so called Parametricism but it is takes a different apporach in Bjarke Ingels architecture. In his 2010 Yes is More Manifesto, he argues:

What if design could be the opposite of politics? Not by ignoring conflict, but by feeding from it. A way to incorporate and integrate differences, not through compromise or by choosing sides, but by tying conflicting interest into a Gordian knot of new ideas (…) An architecture where you don't have to choose between public or private, dense or open, urban or suburban, atheist or Muslim, affordable flats or football fields. An architecture that allows you to say yes to all aspects of human life, no matter how contradicting (…) A pragmatic utopian architecture that takes on the creation of socially, economically and environmentally perfect places as a practical objective. (Ingels, 2010, p.14)

Automotive manufacturers alike, are trying out different platforms, hybrid and electric and using technology to improve safety and consumption with autonomous driving capabilities gaining ever more importance. New uses, services and modes of ownership vs sharing will probably define the next years and automotive OEM's are preparing for the future with concepts such as the studio designer's choice BMW next 100, which combines different technological elements in a morphing exterior and a semi-autonomous, highly responsive user-interface interior environment. Automation and connectivity will probably change the way automobiles are designed just as other products will (Figure 54). Sci-fi futurists and designers such as Daniel Simon, former automobile designer, concept designer for Hollywood movies but also industrial designer for Space X and Roborace, has been a big influence in the industrial design visual culture of the latest years and hence, was a common choice between studio designers for the Future theme. His work is depicted in Figure 55, in the racing autonomous version of Formula 1, Roborace.

Figure 54 : Designer's choices for "Future": BMW NEXT 100 from 2006
Source: http://www.carstyling.ru/en/car/2016_bmw_vision_next_100/ (Accessed: Dez.2016)

Figure 55 : Designer's choices for "Future": Daniel Simon's Roborace car
Source: http://danielsimon.com/wallpapers/ (Accessed: Dez.2016)

Synthesis of the chapter

Review of fundamental texts on Design History, with a focus on texts referring to social, technological and market changes and their connection to the profession of industrial design and design consultancies (from the 1850 to present). The following topics were addressed:

- Designer as a mediator between human and technology;
- Industrial design as a profession born from the industrial revolution and the capitalist market, which evolved into being a product / service design oriented profession in the 21st century;
- Relationship between design and Popular Culture, specifically Sci-fi cinema, Comics, Architecture, etcetera.
- The future trends in the design field, considering technological achievements and social changes;

This overall approach to industrial design, its social, technological and artistic context, comes as a reference to the way Almadesign was founded in a culture and market which has become more globalized. The different references, from design schools to technological advancements were fundamental for its genesis and process. For this reason, it was thought that a context regarding industrial design and the Form Language since the birth of the profession was relevant to this research. This chapter also helped define the studio's culture, with styles and Form Languages which reflect the choices of studio's designers, which result from the Experimental Study #2. This study named "Box of Favorite Things" collected a series of Design references chosen by each designer, which reflect their personality, tastes, design education, visual culture. These results were used as the framework to establish the boundaries of the literature review on form language in design history.

In order to analyse the information in a simple, visual way, the following Table 2 provides a summary of the main findings organized by Period, Movement, Technologies and Form Language associated. This enables a view of the most relevant information collected in the same page and provides a good comparision / evolution tool for analysis.

Table 2 - Summary of Literature Review on Context - Form language in design history

LITERATURE REVIEW: CONTEXT – FORM LANGUAGE IN DESIGN HISTORY			
Period	**Movement**	**Technologies**	**Form language**
1850 – 1900 The First Machine Age	Art Nouveau Arts and Crafts	Steam engine 1st Industrial Revolution Railway industry	Reaction to the "first machine age" and mass production; Handcrafted, craftsmanship, handmade, small series production; ornamentation
1900-1950	Modernism De Stijl Streamlining	Electricity Automotive industry and mass production Atom bomb Jet engine Commercial aviation	Design for mass production; modernism and minimalism; elimination of historical references and ornamentation; Aerodynamic lines are converted into symbols of modernity and progress; design and technology become the force of the mass consumption society; war efforts and aviation design have a huge impact on the form language of products in the next decade;
1950-1975	The Jet Age Organic Design	New technologies born during the war effort are applied to products; Plastics technology, Composites Birth of the transistor;	Aviation inspired automotive design; rocket age and sci-fi are influential in industrial design in the US; golden age of fins and planned obsolescence overstyled automobiles; Organic Design of the 60's with new plastic and composite technologies; design for mass consumption; 60's counter culture clash against consumerism;
1975-2000	Post Modernism	Personal computers Automation of assembly lines Mobile communications Birth of the Internet	70's oil crisis leads to environmentalism and the need for "rational design" 80's bring the reintroduction of symbolism, against modernist ideas Product semantics and the symbolic qualities of form Birth of human machine interfaces in computers
2000-2025	Industry 4.0	Age of the Internet Digitalization Service design Full Automation and Internet of things Mobility mass electrification Low cost 3D printing	UIX: Digitalization, dematerialization More is more: everything is possible in design Parametricism; Hybridization of styles based on technology Co-creation; DYI movement;

(source: researcher, 2017)

2 Form Syntax

2.1 *Introduction*

This chapter is about establishing a theoretical framework around the investigation vector "Form Syntax", defined as the review of texts with focus on the form elements and design principles of products, and the way they are developed into a specific Form Syntax. Borja de Mozota (2003) defines product form as the following:

> *"A product form represents a certain number of chosen elements united as a whole by a design team to produce a particularly sensory effect (Lewalsky, 1988; Hollins & Pugh, 1990). Designers make choices about the size, scale, rhythm, proportion, materials, color, surface, ornamentation, and texture, mixing these elements to achieve a certain level of unity (Davis, 1987)" (Mozota, 2003, p.95)*

Sytanx is, according to Vihma (1989), the study of the design grammar, which by comparison to linguistics we could define as being the set of rules which govern the composition of the (Form) Language. In a practical approach, again with the language comparison, we can build up on the concept through an analogy with basic language elements – words in a spoken language equal design elements in product design – and the way they are arranged in sentences in a spoken language or in products, in design – grammar vs design principles.

2.1.1 Objectives

The main objective of this section is to establish a theoretical framework around the topic of "Form Syntax", in order to define a set of structural rules governing the composition of a From Language – how its different design elements are generated and organized through design principles. These rules will then be applied to analyze the different Almadesign Case Studies, seeking to characterize the "Form Syntax" of the studio.

2.1.2 Methodology

An initial list of authors and texts selected by the researcher and supervisors was analysed in the light of the research vector, Form Syntax. As the research as developed, new texts and references were added whenever considered relevant. The following topics were addressed:

- Form elements;
- Visual Perception;
- Gestalt Pinciples;
- "Universal" Principles;
- Topology
- Organization of form elements

The main approaches analysed include form design manuals (Mike Baxter), design aesthetic development techniques (Lewalski), product experience scholars (Schifferstein and Hekkert), the Gestalt theorists (Wertheimer, Kohler and Koffka), present day design psychologists such as Donald Norman and Design researchers working on the analysis of Form Language and brand perception, such as Warrel and Karjalainen. This literature review was developed as the support framework to the "Case study" analysis of three Almadesign projects (see PART IV), which include the analysis if the design elements and its organization through design principles.

2.2 ***Form Syntax***

The process of literature review on Form Syntax resulted from the need to analyze specific Almadesign projects – Case Studies – and identify form elements and design principles which build a specific Form Syntax. Designers give shape to products, they define their geometry, function and performance. In doing so they develop specific design elements, shapes, use specific materials and colors and build compositions. The way in which the designers develop them is analyzed in terms of literature study and applied in the Case Study review of Almadesign projects. In the combination of these two methods – literature review and Case Study analysis – it is expected that a specific mapping of the studio's Form Syntax is possible, finding the patterns and organizational design principles behind the designs. Let's start by defining what we mean by Form Syntax in the context of this investigation. Encyclopedia Britannica presents the following definition for the word "syntax":

> *Syntax (is) the arrangement of words in sentences, clauses, and phrases, and the study of the formation of sentences and the relationship of their component parts. In a language such as English, the main device for showing the relationship among words is word order; e.g., in "The girl loves the boy," the subject is in initial position, and the object follows the verb. Transposing them changes the meaning. (https://www.britannica.com/topic/syntax - accessed in November 2017)*

Anders Warrel (2001) refers to Form Syntactics as being concerned with the "structure and composition of the visual product form". In order to accurately model form syntactics (adapted to this investigation as Form Syntax) he includes two basic concepts: form elements and form entities. He includes form elements and their configuration (organization) but he also mentions the concept of form entities, which is where the reasoning about product form comes to place and hence form entities deliver syntactic and semantic functionality to the product form. For the investigation, we will focus on the form elements definition for the Syntax part, and consider their organization through design principles. Later on, we will address semantic functionality on the chapter about Form Semantics.

The different "building blocks" of the spoken language, that is, the words and their arrangement into sentences, clauses and phrases can be, by analogy be compared to design elements arranged into products. So we could argue, in the context of this investigation, that "Form Syntax" can be defined as the set of "design elements" and rules of arrangement - "design principles" - in products, defining its visual-spatial and material characteristics. To make it simpler we can define Form Syntax in the context of this investigation as "the arrangement of design elements through design principles which define a product's appearance." The different aspects of the Form Syntax will be analyzed in the following pages: Form elements, Visual Perception and Principles of Design.

2.2.1 Form elements

When we look for the definition of the elements of design we can use an analogy with the elements of art, as the building blocks with which the design develops the product. Typical design elements in

art would be according to the J. Paul Getty Trust:
(http://www.getty.edu/education/teachers/building_lessons/formal_analysis.html - accessed in November 2017):

- *"Line: mark with greater length than width. Lines can be horizontal, vertical, or diagonal; straight or curved; thick or thin".*
- *"Shape: Shape is a closed line. Shapes can be geometric, like squares and circles; or organic, like free-form or natural shapes. Shapes are flat and can express length and width."*
- *"Form: Forms are three-dimensional shapes expressing length, width, and depth. Balls, cylinders, boxes, and pyramids are forms."*
- *"Space: Space is the area between and around objects. The space around objects is often called negative space; negative space has shape. Space can also refer to the feeling of depth. Real space is three-dimensional; in visual art, when we create the feeling or illusion of depth, we call it space."*
- *"Color and value: Color is light reflected off of objects. Color has three main characteristics: hue (the name of the color, such as red, green, blue, etc.), value (how light or dark it is), and intensity (how bright or dull it is)."*
- *"Texture and pattern: Texture is the surface quality that can be seen and felt. Textures can be rough or smooth, soft or hard. Textures do not always feel the way they look; for example, a drawing of a porcupine may look prickly, but if you touch the drawing, the paper is still smooth;"*

Very simple elements can be organized in order to produce different results. This organization is closely related to the way our visual perception works, that is how our visual system perceives visual product form. Such relations are part of the "Gestalt rules" (Warrel, 2001). On researching on the development of form and its syntax, and on the methodologies used to develop form in design, the basic competence I found in the years of my own practice is that sketching and 3D modelling are the fastest ways of conceptualizing ideas. At Almadesign studio, sketches are often the beginning of the design concept phase (or ideation phase) for almost every transport project, considering also the use of 3D modelling using CAD tools or physical models.

Sketching is still a big part of the design processes and this research would keep getting me engaged with sketching information. Dutch designers and teachers Koos Eissen and Roselien Steur published several books about the subject of sketching and product design presentation. In the latter, the authors analyse form finding techniques and presentation techniques for designers and use a theoretical framework which provides an excellent practical base for designers as an eminent empirical approach, based on sketching and designing to develop Form Languages. They propose to organize their theoretical approach in the following way: perception in our reptilian brain; design communication and gestalt principles. This was found to be an excellent approach in defining the Form Syntax underlying any visual language or form language process in a design studio. And so the researcher used a similar approach in trying to identify the Form Syntax elements in the studio's Form Language.

2.2.2 Principles of visual perception

The development of specific form elements or entities in design is the way designers give shape and geometric definition to the object to be build. Gathering knowledge on different aspects such as methods of production, materials, economy of production, human factors but also cultural aspects, marketing aspects, etcetera, requires different skills from the designer. But he also oversees the aesthetical quality of objects and the way he can somehow influence the way the product looks and feels will also influence the perception that users will have in utilizing it, in wanting to buy them, etcetera.

> *"A form entity can be described as a "stylistic component". As the designer starts thinking visually about a design problem by commencing his sketching process, form entities develop as a result of some design intent guided by a design format (articulated or not by the designer). Form entities can thus be represented as very preliminary and rough form ideas during the early sketching phase of a design project, or as final form solutions of a finished design. Any expression of form, visualized at any stage of the design process such as sketches, renderings, drawings, real or virtual models, and appearing in different states of abstraction, completeness and detailing, can thus constitute a form entity." (Warrel 2001, Paper B, p.193)*

In order to understand how the designers develop form and how our brain processes visual communication we will start by analysing the three types of processing. Eissen and Steur (2014) refer to our "three brains": old brain, midbrain and new brain. A similar idea is used by Donald Norman (2007) in defining three levels of processing: visceral, behavioural and reflective. They argue that the new brain is responsible for reasoning, logic, the midbrain for emotion processing and the old brain to help you survive. The old brain controls the unconscious bodily functions but also instinctual impulses in support of survival (fight or flight mechanism, hoarding, dominance, personal grooming, mating) working unconsciously with great impact. This brain plays an important role in perception and is referred to as the reptilian brain. The three "brains" work together in the way we choose to respond to different visual triggers. Nevertheless, the reptilian brain is so important in perception that the evocative ways of referring to danger, food and sex is always a way to get people's attention, evoking "gut-level" actions. This is the visceral manner of processing visual information, which is aided by more complex levels, behaviourally and reflectively (Eissen and Steur, 2014). The authors explain the three levels of processing and its relation to visual language:

> *"What we call the visceral level is connected to our "old" or "reptilian" brain level. At this level automatic and rapid judgments are made, unconsciously. This is what we call our gut feeling. It is a reaction to external appearances, causing us to label something as "pretty" or associate a colour with a mood, for example. This level determines how something affects us and from this response emotions arise. The behaviour level has to do with effectiveness of use and can enhance or inhibit both other levels. The third, the reflective level, is the one that rationalizes and intellectualizes. It has no direct sensory input, but guards and tries to bias the behaviour level. It is especially this level at which cultural differences become clear; opinions*

are formed which then influence and alter our behaviour. The visceral level is pretty much the same for all people; it works through pattern matching. Even though our original cave habitat has made way for city and country dwellings, our old brain is still actively looking for patterns that were programmed at an early stage in evolution" (Eissen, Steur, 2014, pp 18)

Just as Donald Norman refers to three levels of processing, also Lewalski (1988), an accomplished industrial design in the USA does it by referring to 3 levels of aesthetics in products:

- Visual order (or ''reptilian brain level', where we can argue that the primitive brain handles the general perception and gut feeling, working in pattern matching)
- Functionalism (or 'behaviour level', where you intellectualize the way the object works and appreciate its functionality and effectiveness of use connecting its practicality and aesthetic value, potentially inhibiting both other levels)
- Visual Taste (or "reflective level", with no sensory input, where the cultural effects and your personal experience can override the first two, because of the stronger influence of the reflective brain)

Eissen and Steur (2014) go on to argue that this reptilian level of processing helps us distinguish positive and negative patterns. This would of course fit our survival instincts, e.g. bright colours, symmetry and smooth shapes (flowers and fruits) vs harsh contrasts, darkness, too dense environment (watch out alarms for safety, sudden changes in light, sharp objects, etcetera)a. But the "acquired taste" of the behavioral and reflective brains, will eventually override visceral responses as we grow older and have more experience:

"Things that are viscerally negative can become reflectively positive. For instance, we get used to (or overcome our fear of) crowds or noisy cities. Another example is that many delicious and rich diches include a bitter taste. Additionally, our colour preferences get richer and subtler. The exploration and appreciation of things beyond the limitations of the visceral level is referred to as an "acquired taste". As we develop (…) the behavioural and reflective level will gain increased influence. The behavioural and reflective levels are sensitive to training, education, (sub) culture and fashion (trend). This explains why certain viscerally pleasing/positive patterns, such as symmetry or highly saturated colours, are not considered pleasant by all people (…)" (Eissen & Steur, 2014, pp 19)

We can make an analogy to what Hofstede (1991) refers to as the three levels of uniqueness in human mental programming, which he refers to as "personality" – specific to each individual, both inherited and learned, "culture" – specific to a group or category, learned and "human nature", universal and inherited. This three levels of processing will have an influence on the perception of form but also on the perception of functional and aesthetical qualities of visual form. And because some aspects are essential for surviving, humans will unconsciously read shapes and forms in a certain way, before even making sense of them rationally or intellectually. For instance, we have the tendency to read "emotion" everywhere as this is essential for surviving. We tend to anthropomorphise elements, projecting human motives in objects and products. Visual order and simplicity are principles all designers are generally more or less aware of. Being instinctive or through learning processes, these principles are, as we have just seen before, incorporated in our reptilian brain and are intuitive and instinctive to us. This does not mean they cannot change over time (just as a dissonant sound gets more and more interesting as you learn music or shift from tonal to atonal compositions), they do, but a basic understanding of this qualities helps designers get simple, quick solutions to problems and do that in a way they can be understood – at least at a visceral level – by users in different cultures and with different backgrounds. We can say that these rules can have a certain universal appeal, because they are hardwired into our basic, first level, perception system. Researchers in the beginning of the 20th century tackled these issues, in what was called the Gestalt psychology, which provided the foundation for the modern study of perception.

2.2.3 Principles of Gestalt

> *The visual system is not a passive machine but actively tries to make sense of the surrounding world. It reconstructs the world on the basis of visual input into meaningful units. (Harold t. nefs, apud Schifferstein & Hekkert, 2007, pp 31)*

Our visual perception works to achieve a simple organization, which means it tries to organize the images into specific shapes, the more simple and regular the best. The Gestalt theory defined over 140 principles of perception - which can help designers achieve order and aesthetical balance - and we will focus on 8. Taking into consideration the "reptilian brain" approach, the Gestalt rules can offer us ways to interpret the way people perceive visual information and thus different Form Languages. Designers can use this information to design products and guide the user's eye towards certain features, enhancing functionality or esthetical appeal for instance. Eiseen and Steur (2014), when analyzing gestalt principles in sketching and visual representation techniques claim the following:

> *"(…) we not so much focus on the separate elements we see, but rather have the tendency to group them together into something greater, which may be very different from the elements themselves. The whole is different from the sum of parts (…) We look for meaning and also tend to look for a relationship between the elements we see. As a result, we generally find harmonious images more pleasant to look at than those without harmony. On occasion, you may even find yourself recognizing shapes where they do not exist, such as seeing clouds shaped like an animal (…) Although the (principles of Gestalt) do not prescribe how best to present your visual info (…) they do indicate the manner in which this info is perceived" (Eisse &, Steur, 2014, p. 31)*

For the purpose of analyzing the ways users perceive different Form Languages, it was found useful to take a deeper look into the most influential (according to the authors) principles of the Gestalt (Eissen & Steur, 2014):

Principle of Pragnanz (Figure 56):

We try to organize or reduce visual information to the simplest form possible, regular, symmetric and orderly. “even in complex shapes we try to see something simple and meaningful (…), this means we tend to see contours and silhouettes of simple objects even if they are made up of different textures, we try to see the “big picture first. “What your eyes record is not what your brain perceives. We simplify, select and interpret”. Actually, the same process happens when we are drawing something from a reference, where we always interpret and try to draw it using basic shapes first, or contours and silhouettes, or even motion lines which indicate the main axis of the objects. “(The brain) continuously closes the gap between observation and knowledge. That is the “cognition” part of perception” (Eissen & Steur, 2014).

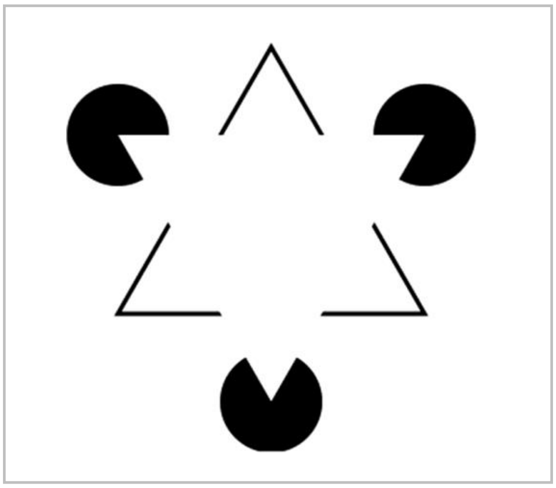


Figure 56 : Gestalt principle of Pragnanz
Source: https://en.wikipedia.org/wiki/Illusory_contours (Accessed: Aug.2017)

Principle of Closure (Figure 57):

“According to this principle, we complete incomplete images or objects in our brain”. This means the parts are completed in order to reach a more stable outcome or balanced solution. “We fill the visual gaps”. (Eissen & Steur, 2014).

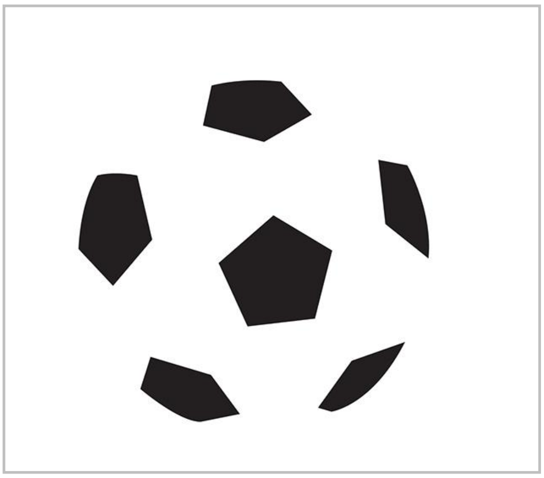


Figure 57 : Gestalt principle of Closure
https://psychhistoryandsystems.wordpress.com/2017/09/01/gestalt-psychology/ (Accessed: Set.2017)

Principle of Symmetry (Figure 58):

"We tend to perceive objects as being symmetrical". This means we unconsciously tend to group symmetrical objects into one shape. (Eissen & Steur, 2014)

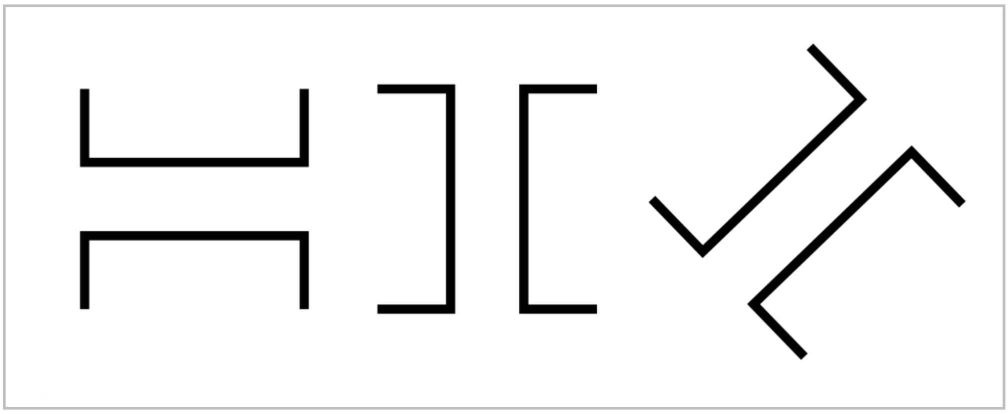


Figure 58 : Gestalt principle of Symmetry
https://documents.tips/documents/visual-perception-in-design.html (Accessed: Aug. 2017)

Principle of Similarity (Figure 59):

"We have a tendency to group together elements or objects that have similar features; that look alike. The feature that connects them can vary: colour, value, texture, size, position, etc. For example, brand identity is based on this principle, among other things". This does not mean we appreciate similarity always, could be boring and unpleasant, impersonal (mass production): "After having used mass-produced products for an extensive period of time in western culture, we are now starting to appreciate the irregularities in handmade craftsmanship again" (Eissen & Steur, 2014).

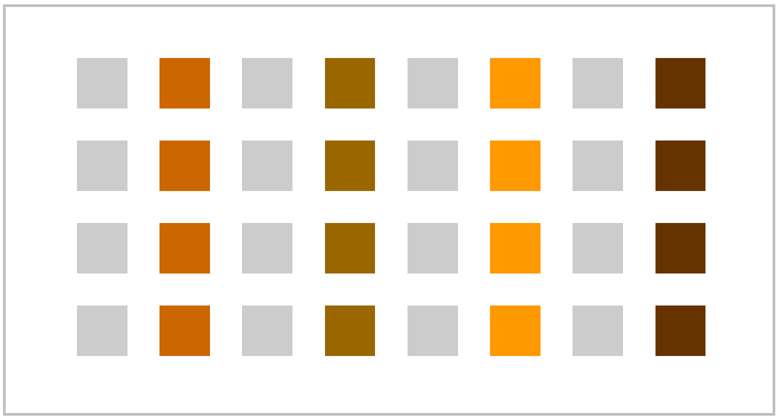


Figure 59 : Gestalt principle of Similarity
Source: https://www.usertesting.com/blog/2016/02/24/gestalt-principles/ (Accessed: Aug. 2017)

Principle of Proximity (Figure 60):

"This is the perceptual tendency to group visual elements that are in each other's proximity together, whereas elements further apart are seen as independent, or not connected. This (...) causes us to perceive groups or chunks rather than unrelated, independent objects" (Eissen & Steur, 2014).

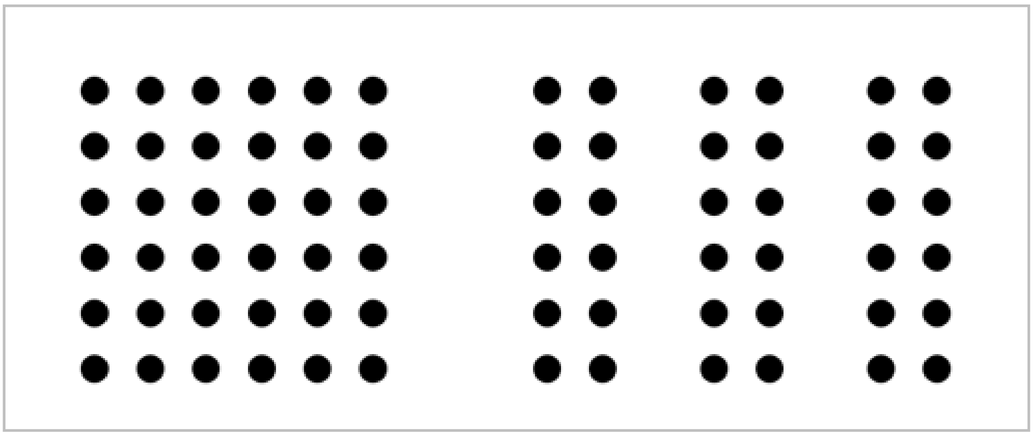


Figure 60 : Gestalt principle of Proximity
Source: https://digitdesignblog.wordpress.com/2016/09/05/gestalt-teori/ (Accessed: Aug.2017)

Principle of (good) Continuation (Figure 61):

"(…) captures the idea that elements following a consistent direction are perceived to be connected to each other. In this manner, the brain can perceive lines, even if they are not really there. Because of this we can (…) make a distinction between 'figure' and 'ground'" (Eissen & Steur, 2014)

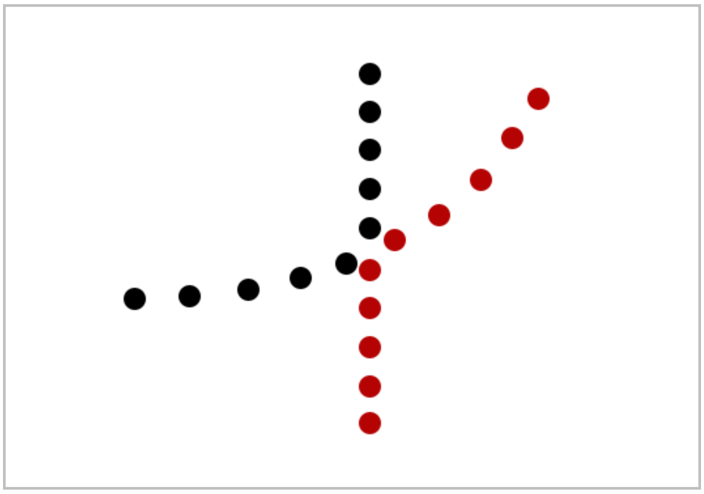


Figure 61 : Gestalt principle of (good) Continuation
Source: http://sites.psu.edu/psych256fa14/2014/09/14/gestalt-laws-of-perceptual-organization/ (Accessed: Aug.2017)

Principle of Experience (Figure 62):

"We automatically compare things we perceive with what we already know. Designers of icons have made grateful use of this principle." This principle also has to do with consistency in the way forms, shapes, or other kinds of visual information are described. (Eissen & Steur, 2014)

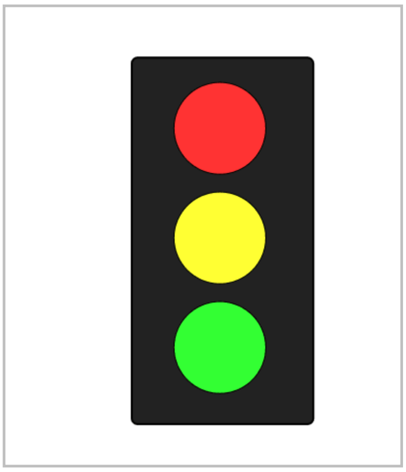


Figure 62 : Gestalt principle of principle of Experience
Source: https://psychhistoryandsystems.wordpress.com/2017/09/01/gestalt-psychology/ (Accessed: Aug.2017)

Principle of Figure/Ground (Figure 63):

"The eye distinguishes objects from their surroundings. Objects such as silhouettes, forms or shapes naturally become the 'figure', while the surrounding area becomes the background or 'ground' (…) This principle also dictates that when the viewer has to make the mental choice between two interpretations, this is impossible, as he or she can only see one" (Eissen & Steur, 2014)

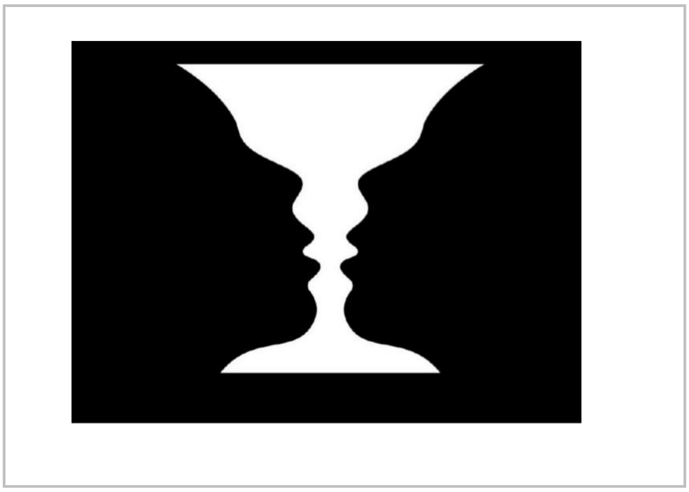


Figure 63 : Gestalt principle of Figure/Ground
Source: http://researchmatters.psu.edu/2016/06/16/optical-illusions-and-the-view-from-space/ (Accessed: Aug.2017)

The Gestalt principles and optical illusions can help designers tackle different form language problems. An interesting example is the way a designer can make an object look longer, just by designing lines and taking into account optical illusions. Figure 64 presents and example, in which the total length of the horizontal lines is the same in both cases, but looks much longer in the example below.

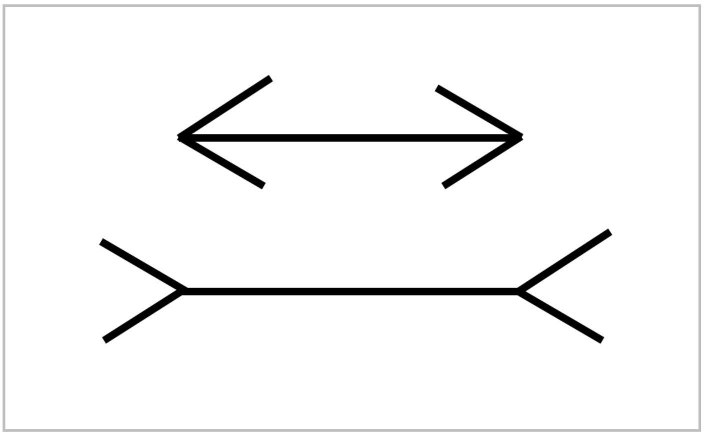


Figure 64 : Optical ilusions: horizontal lines are the same length, but look different
Source: Researcher, 2017

The simplicity supported by the Gestalt rules alone does not justify the greater aesthetic appreciation of a product. This question is studied by psychologist Daniel Berlyne, who revealed a preference curve in which both a simplistic or overly complex product is considered less attractive (Berlyne, 1960). This means designers need to take into account order but also diversity. The most attractive products are, according to Berlyne, those that contain some degree of complexity, according to a particular preference curve – the Wundt curve.

> *"Berlyne's own research showed that increases in the uncertainty of visual figures were positively correlated with people's ratings of pleasingness according to the predicted Wundt curve; the most pleasing figures were those of moderate levels of uncertainty and rated as being moderately complex." (Crozier, 1994, pp 65)*

Although other authors dispute these results, most authors consider that Berlyne's assumption is generally correct. Familiarity with objects is another factor that plays an important role in the question of aesthetic preference (Crosier, 1994). There are also contradictory theories, such as Fechner's (1876), which show that preference is correlated with exposure. That is, the more we are exposed to an object, the more our aesthetic appreciation increases, at least to a degree of saturation and indifference. Figure 65 depicts Berlyne's model of aesthetical response, showing that a certain balance between simplicity and complexity (measured by the arousal potential) is needed because there is a threshold for the level of complexity after which the user starts to lose interest.

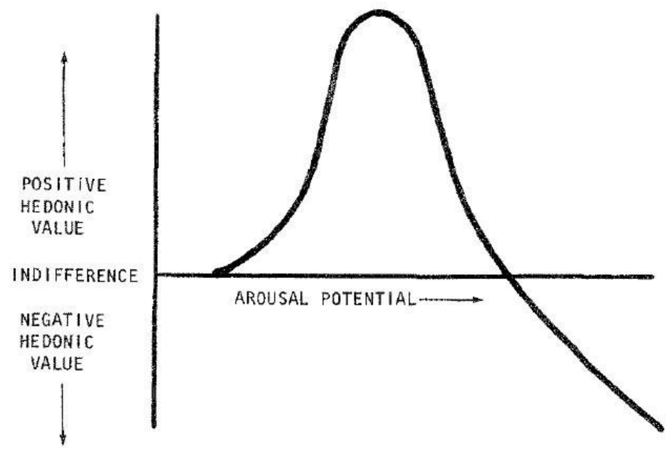


Figure 65 : Berlyne's model of aesthetic response, 1970[5] (Berlyne, 1970)
Source: http://www.bartneck.de/publications/2008/designingForExperienceBoredom/ (Accessed: Aug.2017)

[5] *reprinted form Walker, 1970, pp.109)*

Eissen and Steur go on to conclude about the principles of the Gestalt in visual sketching and representation (and the same can be said, by analogy, about Form Language in product design) when considering 2D representations (and not actual products):

> *"Without variety and complexity, images may end up static or uninteresting visuals. At its extreme, simplicity will disengage the viewer, leading the human brain to reject under-stimulating visual information. However, too much variety won't work either (…) similarly leading the human brain to reject what it cannot organize or understand" (Eissen, Steur, 2014, pp 72)*

So, a balance between variety and complexity is encouraged in the development of a Form Language which is to be considered aesthetically pleasing. Can we also define some generic principles, which can be said to be universally appealing, even though they could be processed in our brain at different complexity levels? Some authors argue there are universal principles of design, which, at least at a visceral level, can be appreciated by users in different cultures and with different backgrounds. By using these principles, they argue, it is possible to define some rules to building a Form Language with a potentially global appeal. We will have a look at some of these principles, in order to check if they are included in the Form Language developed at Almadesign studio.

2.2.4 Principles of Nature

> *"Sound design in not only within the reach of a small set of uniquely talented individuals, but can be achieved by virtually all designers. The use of well-established design principles increases the probability that a design will be successful (Lidwell, Holden, Butler, 2010, p. 13)*

William Lidwell, Kritina Holden and Jill Butler (2010) published the "Universal Principles of Design" to provide access to cross-disciplinary design knowledge. The design principles used are not, of course, all the existing design principles and a designer can, and should, be able to break the rules. Nevertheless, some design principles are useful in designing and in building a specific form syntax. In this regard, it was found useful to look at some of the principles, specifically the ones directly related to form development, which can then guide the principles around organizing form elements. The following two groups of principles were considered for this research.

2.2.4.1 Anthropomorphism principles

Anthropomorphic form is defined by "a tendency to find forms that appear humanoid or exhibit humanlike characteristics appealing" (Lidwell, Holden, Butler, 2010). The authors explain that humans are "predisposed to perceive certain forms and patterns as humanlike – specifically, forms and patterns that resemble faces and body proportions" (Lidwell, Holden, Butler, 2010). They argue:

> *(Anthropomorphic form) when applied to design, is an effective means of getting attention, establishing a positive affective tone for interactions, and forming a relationship based, in part, on emotional appeal. (Lidwell, Holden, Butler, 2010, pp27)*

The reference to "emotional appeal" is considered to be very important. As we will see further on in this research, this was something which was clearly stated during one of the Experimental study Studies session at Almadesign, where designers mention the fact that a design must have an "emotional" appeal which can be understood at a visceral level. The authors mention the fact that abstract forms are preferred other than realistic ones, this is designers should consider a certain degree of abstraction in using this principle as "realistic depictions often decrease, not increase, aesthetic appeal (Lidwell, Holden, Butler, 2010).These principles work at various levels and certainly could very much vary from culture to culture, as we have seen that the visceral perception levels are override by the more reflective ones. Nevertheless, it is interesting to note the universal acceptance of certain forms over history, particularly in the case of automotive design. "People's cars" such as the VW Beattle (in Germany), the Mini (in England), the Fiat 500 (in Italy) or the Citroen 2CV (in France) all share a formal "friendly" language with anthropomorphic connotations. They became so successful that they become socio-cultural icons of their times. The choice of simple, friendly and anthropomorphic formal languages possibly contributed to the success of these models globally: they are perceived to be like babies or pets. Carl DiSalvo and Francine Gemperle (2003) consider that the use of anthropomorphic form in product design also serves to solve communication and user interface problems (DiSalvo, Gemperle, 2003). They mention the long tradition of using the anthropomorphic form in human artefacts and suggest:

> *"(Anthropomorphic characteristics) are used to explain relationships with and exert authority over objects. They serve to: keep things the same; explain the unknown; reflect product attributes; reflect human values." (DiSalvo, Gemperle, 2003, pp 6)*

In the case of anthropomorphic references, we can therefore hypothesize that there is a universal language of comprehension based on the characteristics of anthropomorphic recognition and even in the association of human personality characteristics with artefacts. This is a known fact to designers and can be used as a strategy to "infuse" personality using specific form features. Figure 66 presents a clear example of the use of anthropomorphic form elements to "infuse" a personality on an automobile: "Cute" (VW new Beetle) or "Powerful and Aggressive" (Dodge Ram).

Figure 66 : VW new Beetle and 3rd generation Dodge Ram from 2002 (source: researcher)

In fact, in the case of “friendly” small cars we can even mention a specific design principle, which we can include as an anthropomorphism, which the authors define as the “Baby/Face Bias”. This is a principle by which there is a “tendency to see people and things with baby/faced features as more naïve, helpless, and honest than those with mature features” (Lidwell, Holden, Butler, 2010). The authors explain:

> *People and things with round features, large eyes, small noses, high foreheads, and short chins (…) are perceived as baby like and, as a result, as having baby like personality attributes: naiveté, helplessness, honesty, and innocence. The bias is found across all age ranges, cultures (…) (Lidwell, Holden, Butler, 2010, pp 34).*

This raises the question of the “face” of the product which is something particularly important in automotive and transport design in general, as users associate the form with specific personality traits, e.g. the VW Beetle with a simple, naïve personality. In the same manner, automotive cars with “menacing” faces are associated with power and even to a threat, which draws and maintains attention of the user. These associations can also be considered anthropomorphic or zoomorphic, due to their visual similarity towards humans or animals. Some brands, such as Mazda with its “Soul of Motion” design language, state this relationship in their communication directly:

> *“A car isn't simply a mass of metal. Mazda believes it's more like a living creature. Creating an emotional bond between a driver and their car comparable with the relationship between horse and rider. That's the ultimate goal of Mazda's KODO design” (Maeda, 2010)*

Mazda even presents the new form language (design philosophy) with sketches of animals such as the cheetah, incorporating elements form nature to anthropomorphize or zoomorphize and infuse a “living” personality to the design. Figure 67 depicts the prototype which expresses the KODO form language:

Figure 67 : Mazda SHINARI, presented in 2010, expresses the form language of KODO
Source: http://www.mazda.com/en/innovation/design/ (Accessed: Dez.2017)

2.2.4.2 Golden Ratio, Biophilia, Self-similarity principles

Nature was always an inspiration to designers and architects. From Da Vinci, to Gaudi, to Zaha Hadid, designers and architects have looked at nature for inspiration and analogies. We can define different types of mimicry in nature: Formal, Functional and Process related. In the case of this investigation, and because we are dealing with product design we will focus only on formal and functional analysis.

Nature influenced designs are something which have appeared as references in different Form Languages over time. In such a view, it was found interesting to incorporate some of this information into the investigation. We know that the complex structures of growth in Nature can be explained by mathematics and geometry. This is the case of the Fibonacci series that is obtained by summing consecutively the last two numbers of the series (1,1,2,3,5,8,13,21, etc.) and which is present in the growth structure of plants and animals (Baxter, 1994, p.46). The golden number and golden ratio are also mathematical relations that are present in several natural constructions, which man tried to understand and use in the construction of spaces and artefacts and its form language (Figure 68). Different authors have studied these relationships in which it is considered that "The power of the golden section to create harmony arises from its unique capacity to unite different parts of a whole so that each preserves its own identity, and yet blends into the greater pattern of a single whole." (Doczi, 1994)

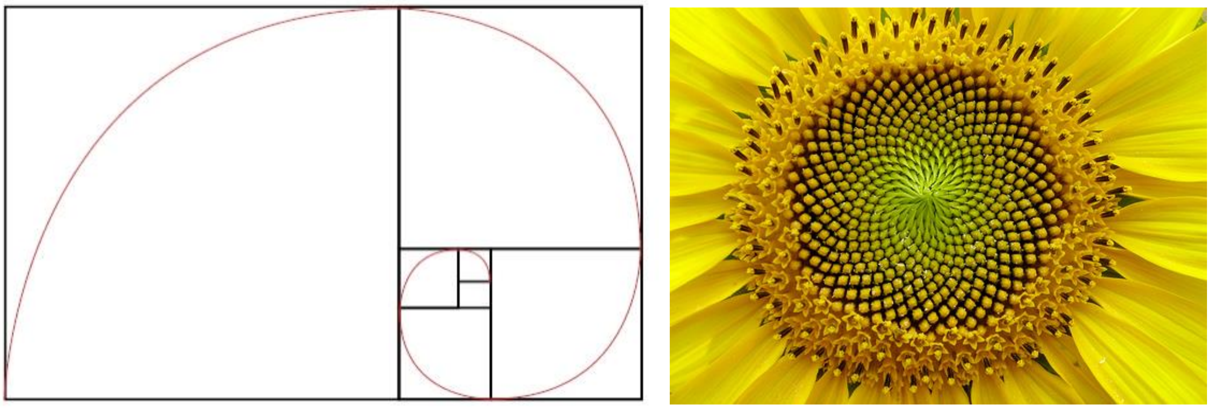


Figure 68 : The golden number and Fibonacci sequences are examples mathematical models in nature
Source: https://www.blogto.com/events/sacred-geometry/ (Accessed: Aug.2017)

At the end of the XIX century, German psychologist Gustav Fechner studied the answer to the qualities of the golden rectangle. Fechner identified several documented references pointing to a "cross-cultural" aesthetic preference for the proportions of the gold section, by dedicating his studies to measuring artefacts and proposing that most people preferred proportions close to those of the golden rectangle. As cultural factors play a key role in aesthetic preferences, it has been found that the author's conclusions are not entirely clear and are considered too simplistic:

> *While many manifestations of the golden ratio in early art and architecture were likely caused by processes not involving knowledge of the golden ratio, it may be that these manifestations result from a more fundamental, subconscious preference for the aesthetic resulting from the ratio. A substantial body of research comparing individual preferences for rectangles of various proportions supports a preference based in the golden ratio. However, these findings have been challenged on the theory that preferences for the ratio in past Experimental studies resulted from Experimental studies bias, methodological flaws or other external factors. (Lidwell, Holden, Butler, 2010, p.114)*

Recently the designer Maggie Macnab (2008) proposed an interpretation of the "codes of design" existing in nature and its relation to the aesthetic preferences of man. Macnab discusses the capacity of human beings to "read" the symbolism of nature and cosmology as a form of adaptation and survival, and proposes a return to these values as an approach to a design methodology:

> *"We have always used the pattern of nature to know when to hunt, when to plant, when to stay and when to move on. Patterns are arrays that unfold in predictable ways to reveal distinct interrelationships that can be grasped through our senses (…) Petals of flowering plants that number five or multiples of five bear fruit edible for human beings (...) five (…) relates to human physical structure, both in quantity and quality – five appendages that*

extend from the torso including the head; five fingers and toes per appendage; five senses in the head region." (Macnab, 2008, p.9)

The seminal work regarding nature design and patterns is Darcy Thompson's 1917 "On Growth and Form" collecting what was known at the time about form and pattern in nature. Pattern creation and form arose from the process of growth, and hence the title of the book. He also cautioned that not all form had grown because of natural selection, sometimes patterns arose from physical forces and not biology. Recently Phillip Ball (2017) refreshed this theme and applies it to the definition of different ways of patterning (and form in nature). He proposes the following areas of observation in nature: Fractals, Spirals, Waves, Bubbles, Cracks, Stripes, Arrays, Tiling, Flow, etc. These patterns and form growth principles have been one of the architecture and design areas of interest since we can register representations of nature in man-made artefacts. Still, nowadays with CAD software being able to create "growing" structures by means of algorithms, the questions is again raised about how to use the "hidden" geometry in nature in form finding procedures. Does form arise from physical forces (form follows performance?)

Also relating to nature's principles and influence on the development of design, the Biophilia effect is a design principle that states that "environments rich in nature views and imagery reduce stress and enhance focus and concentration" (Lidwell, Holden, Butler, 2010). This claim has been tested empirically and "it does appear that exposure to nature confers benefits emotionally, cognitively, and physically" (Lidwell, Holden, Butler, 2010). The authors explain:

Although some non-natural environments may confer similar benefit, nature scenes appear to be the most reliable and consistent source for the general population. Why should nature imagery be more restorative and conducive to concentration than, for example, urban imagery? The effect is believed to result from the differential manner in which the prefrontal cortex processes nature imagery versus urban imagery. However, given that photographs of nature versus urban environments are sufficient to trigger the effect, it is likely that the biophilia effect is more deeply rooted in the brain that the prefrontal cortex – perhaps an innate bias for greenery evolved in early humans because it conferred a selective advantage, a bias likely related to the savanna preference. (Lidwell, Holden, Butler, 2010, p.36).

The biophilia effect is able to reduce stress and increase focus and concentration, by focusing our attention in natural elements (such as vegetation) or even imagery of nature. Another nature design principle, self-similarity is a "property in which a form is made up of parts similar to the whole or to one another" (Lidwell, Holden, Butler, 2010, pp.218). This happens in nature at many different levels of scale and the patterning of these effects, e.g. the "fractal" repetition of the same forms, repeatedly organized in patterns, have intrinsically aesthetic properties. This is a process which can be simulated and copied using mathematical processes such as algorithms, and has proved popular between designers and architects such as the so called "parametricists" of architectural office Zaha Hadid architects:

> *"Naturally occurring self-similarity is usually the result of a basic algorithmic process called recursion. Recursion occurs when a system receives input, modifies it slightly, and then feeds the output back into the system as input. This recursive loop results in subtle variations of the form – perhaps smaller, skewed, or rearranged – but still recognizable as an approximation of the basic form (…) The ubiquity of self-similarity in nature hints at an underlying order and algorithm, and suggests ways to enhance the aesthetic (and perhaps structural) composition of human-centred forms. Consider, for example, the self-similarity of form and function found in the compound arch structures of the Roman aqueducts and the flying buttresses of gothic cathedrals, structures that are beautiful in form and rarely equalled in their structural strength and longevity. The self-similarity in these structures exists at only a few levels of scale, but the resulting aesthetic and structural integrity are dramatic (…) the reuse of a single, basic form to create many levels of metaforms mimics nature's tendency towards parsimony and redundancy (…)" (Lidwell, Holden, Butler, 2010, p.218).*

Self-similarity is in effect a powerful tool in developing a specific form language, in its creation of complexity with order. It is a process by which different form elements can be organized in patterns which can also be treated into strategies for defining a product form and a specific Form Language.

2.2.5 Principles of surface continuity

Designers and architects have approached the issue of surface continuity in their work related to form development. An empirical approach to study the development of form and surface is proposed by Gray Holland (2009), an American designer. The designer proposes that "form, in the context of both the natural and man-made world has two jobs: to be the messenger of a certain experience, and to fulfil on that promise" (Holland, 2009). He goes on to argue that when the 2 don't match up, "the experience is unfulfilling and its form superficial" (Holland, 2009). The designer uses a three-level definition of types of surface continuity form the engineering CAD lexicon: Positional surfaces, Tangential surfaces and Curvature continuities.

These aspects are considered important for the research as the Almadesign methodology incorporates a very big part of CAD modelling, specifically and specially on the design development phase. This means that after the concept phase, in which a lot of sketches and hand drawn material is produced, a mathematical CAD model is to be developed. The studio has been developing these competencies in specific software for at least 17 years, which means it not only has a lot of time invested, but also has accompanied the software evolution over the years.

The strategy to model any object in 3D CAD software relates to the quality of the final design development by means of the resemblance to the sketches approved but also on the surface quality and detailing, which are paramount in building a product which looks, feels good and presents itself as a top-quality product. Different strategies can be used and different software tools are available. Almadesign studio uses Rhinoceros software as the basic modelling tool going from the concept phase to the development phase. This means it is the main tool in materializing the form from an initial 2 dimensions sketch approved by the client. A quick strategy of modelling is by using specific surface modelling tools which allow for a quick “3d sketch” which can then be transformed, scaled or modelled as if it were clay, in a way which allows to very quickly visualize different forms to resolve the design. One of the strategies used implies the use of certain cross-sectional elements, which will be used to build the surface of the object and define the form by pulling and pushing this cross-section around a determined contour or shape. This “core” cross section will help define the overall shape by means of defining lines, different values and reflections (such as the case of an automotive surfacing with glossy paint as a surface finish).

The basic understanding of this cross-section shapes, means designers can then use them in order to build the object and control the way light and shading will work as a tool to modify the perception of the shape. For instance, if they want to reduce the apparent volume and proportion they can add a crease to a surface by which they will create a line on the shape and different areas of light and shadow, thus reducing the apparent volume and changing the “apparent” proportion of the shape e.g. making it look more elongated, “ready to move”, by means of surface treatment. The same can be said using colour or even texture which, by the relation with the gestalt principles, allow designers to guide the eyes of the user into different directions and optimize and aesthetical effect or change the perception of form. Figure 69 presents an example of a 3D CAD model developed at Almadesign.

Figure 69 : 3D CAD surface model of a bus (source: Almadesign archive, 2010)

Hence different cross sections will create different light reflexions, shade and value changes to the product and there are software tools which allow designers to quickly see the results by means of “real-time” rendering possibilities. Gray Holland (2009) argues that this difference in the continuity of the surface (its cross-sections) also is able to communicate different aspects of design in the forms, as they are present (or not) in nature, thus rendering elements which look like they were produced "naturally" or a mechanical machine-like look. These aesthetical aspects are all communicated by the way the surface is more or less continuous. The author goes on to argue in a so called "period table of form" to analyze different surface continuities and their semantic meaning:

> *"If there is an empirical meaning behind form then, how does it manifest across the natural and into the man-made world? Going further with this notion, let's deconstruct the meaning of form naturally, and then distil that meaning into some simplified geometric categories technically. In order to define these categories, I will ironically employ a three-level definition of surface continuity from the engineering CAD lexicon: Positional, Tangential, and Curvature continuities. It's useful to think of these three types as steps in a ladder, with each building on the definition of the last. Positional continuity [C0 or G0] refers to the hard edge created when 2 surfaces intersect. Tangential continuity [C1 or G1] is the next level, defined by a circular arc creating a relatively smooth transition between these surfaces (…) Curvature continuity [C2 or G2] (…) occurs when the rate of curvature between 2 continuous surfaces are the same. Visually, it is when one cannot tell when one surface ends and another begins. (…) The primary benefit of Curvature's quality is the ability to control smooth reflections across multiple surfaces. (Holland, 2009)*

As the author refers, Figure 70 shows a "shaded" CAD model of a positional, tangent and curvature surface (left), and an evaluation CAD "zebra" tool to check for curvature in the same surfaces (right).

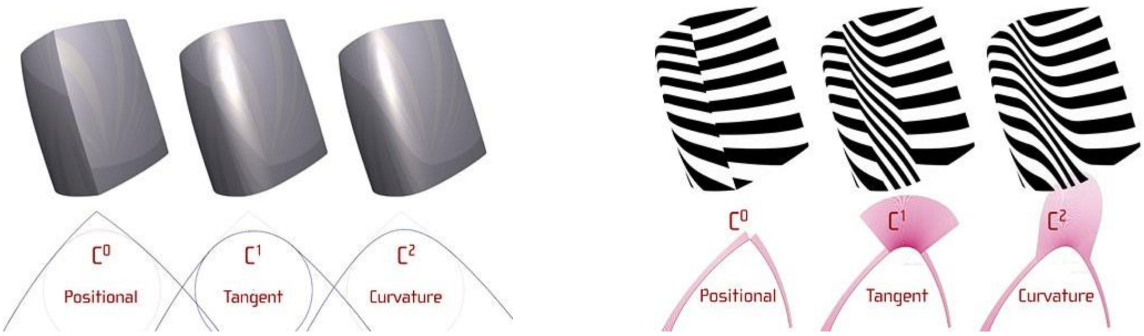


Figure 70 : Quality of surface transition and technical continuity evaluation (source: Gray Holland, 2009) http://www.core77.com/posts/12752/a-periodic-table-of-form-the-secret-language-of-surface-and-meaning-in-product-design-by-gray-holland-12752 (Accessed: Jan.2016)

He goes on to argue that the semantic aspect of this relationship can be found in nature examples, because the surface continuity is largely affected by the performance of the animal, plant or by the exterior physical effects which affect it (for instant great pressures in crystal formed shapes and forms). As users, we will tend to read this shapes as being dangerous because they are sharp, or flowing as if perfectly adapted to their water surroundings. Figure 71 depicts examples of Positional and Curvature surface continuity in Nature. The author argues:

Looking at the diversity of nature yields numerous examples of both Positional and Curvature continuity (…) Examining our emotional responses to these two classes of natural form development, there are distinct sets of impressions they leave upon us: The Positional forms suggest precision, accuracy, danger, structure, fidelity...; *The Curvature surfaces intimate* sophistication, elegance, fluidity, grace, refinement...; *Conspicuous is the nearly complete absence of tangential forms in nature." (Holland, 2009)*

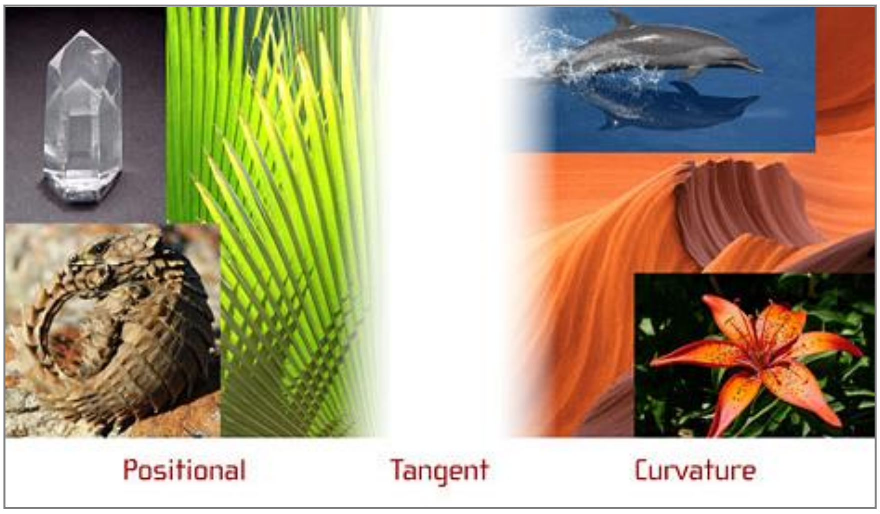


Figure 71 : Quality of surface transition in Nature (source: Gray Holland, 2009)
http://www.core77.com/posts/12752/a-periodic-table-of-form-the-secret-language-of-surface-and-meaning-in-product-design-by-gray-holland-12752 (Accessed: Jan.2016)

By analogy, the author claims users tend to inherently attribute the same meaning to man-made objects, in the relationship between their form and function (or in the case of transportation design, best said in the way form and performance meet). He cites the following examples:

Now taking this same simplified approach to the categorization of man-made forms, especially transportation machinery, we can see similar patterns of meaning arise. The Stealth Fighter and the Cadillac show-car both have a menacing and precise nature. The D-type Jaguar and the B-1 Bomber hold an alluring yet sober elegance (…) Newer to this form-scape are the Tangential forms, and notably they have a very particular and consistent point of view: they all maintain a sense of utility, function, efficiency, practicality, purpose...(Holland, 2004)

Figure 72 depicts examples of Positional, Tangent and Curvature continuity in Transportation design with examples from automotive and aviation design. The different types of surface continuity help define the Form Language of the products.

Figure 72 : Quality of surface transition in Transportation Design (source: Gray Holland, 2009) *http://www.core77.com/posts/12752/a-periodic-table-of-form-the-secret-language-of-surface-and-meaning-in-product-design-by-gray-holland-12752* *(Accessed: Jan.2016)*

The three types of surfacing are of course, as all design processes, closely linked to the processes used to model them in CAD software (positional and tangent can be quicker and easier, due to more automated tools and to less complexity of the connection between surfacing) or in executing them in production, e.g. certain shapes are not easily built using certain materials. That is why some simpler designs reflect their technology in manufacture, such as the steel bending techniques which only allow for certain degrees or curvature, the clay models used for the process of sculpting a car body, of the steal hammering or steel stamping techniques.

All these processes influence the possibilities of the design in terms of real-world materializing. But in the computer the boundaries are different, as the geometries must match but there are no production criteria yet. Figure 73 depicts a Portuguese design (UMM Jeep) as an example of military equipment design using positional continuity for manufacturing reasons. They have to be cheap, easy to build and to repair; surface continuity does not affect performance:

Figure 73 : Vehicle produced using steel cutting, welding and press-bending technologies
Source*: https://www.custojusto.pt/lisboa/todo-o-terreno/umm-alter-ii-100-dti-alter-2-22000631 Accessed: Dez.2017)*

When designers have a choice they can combine these different aspects of surface continuity – bu accessing different tools and technologies which allow them to experiment with form elements of different curvatures – they are able to build semantic relevance with them by controlling light, shadow and value of the surfaces. For instance, the interplay of light and shadow and reflections on a glossy surface, such as that of a car, will create visual variety and complexity and can help find the right balance between volumes as shadow and light values change the visual proportions (i.e. make the object look longer than it is or shorter). Figure 74 shows an example of the automotive design process, in which a clay 1:1 model is covered in glossy film to check for surface continuity by looking at the light reflections. This is considered a fundamental tool in defining the detailed surface geometry by controlling the light reflexion in the bodywork.

Figure 74 : Surface continuity and reflections - Mercedes Vision G-Code Concept
Source: https://www.mercedes-benz.com/en/mercedes-benz/design/mercedes-benz-vision-g-code/ (Accessed: Dez. 2017)

Historically, surface continuity was controlled via the use of "cross section" elements, which is a similar process used in boat design and aircraft design (known as "lofting") and which the computer software has adapted as a command (LOFT) to connect cross sections in an object. Figure 75 depicts a "wooden buck" used to hammer steel plates and build the car's body:

Figure 75 : Wood buck used to hammer steel and build the bodywork
Source: http://www.langemartin.com/metal-work.html (Accessed: Dez. 2017)

Gray Holland then proposes to analyze the different continuities and make a hybridization of the different concepts in increasingly complex ways of creating surfaces. He compares this hybridization to a Form Periodic Table, in an analogy to organize and find new “form” elements (analog to chemical tabular arrangement of elements). By combining different curvature elements, you get new hybrids which create a new form language and its specific expression (Figure 76):

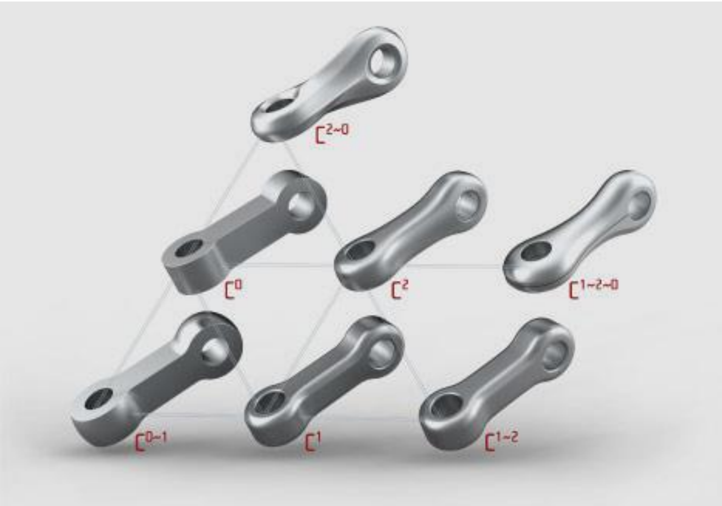


Figure 76 : Combining form elements of different curvatures (source: Gray Holland, 2004))http://www.core77.com/posts/12752/a-periodic-table-of-form-the-secret-language-of-surface-and-meaning-in-product-design-by-gray-holland-12752 (Accessed: Jan.2016)

The author argues that combining the angular “Positional” aspects with the graceful “Curvature” surfaces, produces a sophisticated, exacting, and formidable visual spectre” (Holland, 2004, p.xxx). This approximation and the attempt to "quantify" it through the classification and attribution of a code of meanings refer to a possible organization of forms in a periodic table proposed by the author: analogy with the chemical elements that approaches the quantification of exact sciences. It's an interesting approach because it can be a useful project tool. Patrícia Muñoz (Faculty of Architecture, Design and Urban Studies, University of Buenos Aires) professor of morphology of the form for industrial designers refers:

> *“The control of smoothness in the shape of objects, is influenced by the way in which the form was created and by the different communicational, functional and technological elements that identify a product of industrial design. Subtlety in the suggestion of form, by means of the regulation its continuity, is what turns it suggestive through design.” (Muñoz-López, 2004, pp.24)*

The author considers that the quality of surfaces in a design product is a key element of their communication. It also states that the shape of design products is, as a rule, constituted by the complex union of several simple surfaces. Different degrees of continuity between these surfaces are created through functional, material, technological, but also cultural and aesthetic (semantic) criteria. The author relates the various ways of generating surfaces and their continuity with communicative and aesthetic factors:

> *"The regulation of continuity in the shape of objects, allows us to establish a tension between what is obvious and what is unknown, between what is evident and what is hidden. The interior or the geometry of a shape is partially unveiled through the perception of the covering outside. So, subtlety in the suggestion of form is what turns it suggestive through design." (Muñoz-López, 2004:8) 25*

The regulation of continuity is very important in the form language development of designers and it is also the case with Almadesign. It is difficult to establish specific meanings for each of them as they are guided by analogies form natural objects but also form products already designed and culturally established. Nevertheless, the quality of the surfacing, the balance between order and complexity and the interplay with material qualities all help define specific form languages as we will analyse in Almadesign's case studies. The use of coherent cross-section through the same project helps the obtaining of a constant, coherent form language by means of repetition even at different scales just like it happens in nature with fractal shapes. The kind of redundancy helps in keeping a constancy or higher order but a great complexity, maintaining the balance in between. The use of similar cross section over different project will also help in bringing an idea of form language which is maintained through a family of products. This strategy is used by a number of automotive brands.

2.2.6 Principles of organization

Warrel (2001) elaborates on the relational nature of form entities in order to develop a model about how form is constituted, that is what stylistic components are present, and how they are related. In order to better understand how the author models the organization of form elements, let's look at his argument:

> *"Analyzing the form of a product, different hierarchical levels of form entities can be identified. On the highest level, the product is appreciated as a whole form experience. On intermediate levels, form entities appear as subordinate gestalts, while form details become apparent on the lower resolution levels. Superimposed on each other, these layers together create a total form expression." (Warrel, 2001, p. 194)*

The author makes a distinction between Design Format and Form entities. The first relates to the "ingredients that define a product form a specific manufacturer", "directing the development of a product in a specified direction" (Warrel, 2001, p.104). The form entities are organized into four levels and different ways of distribution, which we can use as a guideline in order to analyse Almadesign's own visual form language. The levels are hierarchically distributed (from the most important to the least) as follows: the "Superior Gestalt", the "Characteristic shapes", the "Signifying curves" and the "Fifth elements". These can be organized using different strategies such as "distributed" or "distinct", can appear as "single", "composed" and can be described as either "discerning" or "connecting". Let's take a closer look at what the author proposes as the organization for the analysis of form entities:

- **The superior gestalt:** Form elements on the highest hierarchical level;
- **Characteristic shapes:** Significant form elements;
- **Signifying curves:** form elements found repeatedly in several components across the product;
- **The fifth element:** a discrete, discerning form element;

Organizing elements is building a gestalt, that is a discernible whole; an arrangement of parts so that they appear and function as a whole which is more than the sum of parts (Mono 1997, apud Warrel 2001). The organization of Form entities is proposed as three pairs of opposites, according to Warrel (2001, p.112):

- **Distributed:** geometrically extended across other form entities;
- **Distinct:** geometrically enclosed;
- **Single:** single entity;
- **Composed:** grouping of form entities;
- **Discerning:** separated from other forms;
- **Connecting:** creating visual couplings between form entities.

The author exemplifies with the analysis of a Case Study using the Volvo Brand. Figure 77 illustrates these concepts, explaining form entity levels, ways of organizing them and form language functions (the author also uses the concept of Aesthetic Organ Models which we will not include in this research). Figure 77 depict the author's analysis on the Volvo Brand and specifically on the Volvo estate model, which was, at the time (2001), the most iconic model of the brand. The author analyses the form language developed by the brand by looking at the specific form entities of the model and describing its form language functions. This approach is analytical and focused upon a finalized product, an interesting parallel can be made in the way designers approach the sketching process (although this is not the focus of this research).

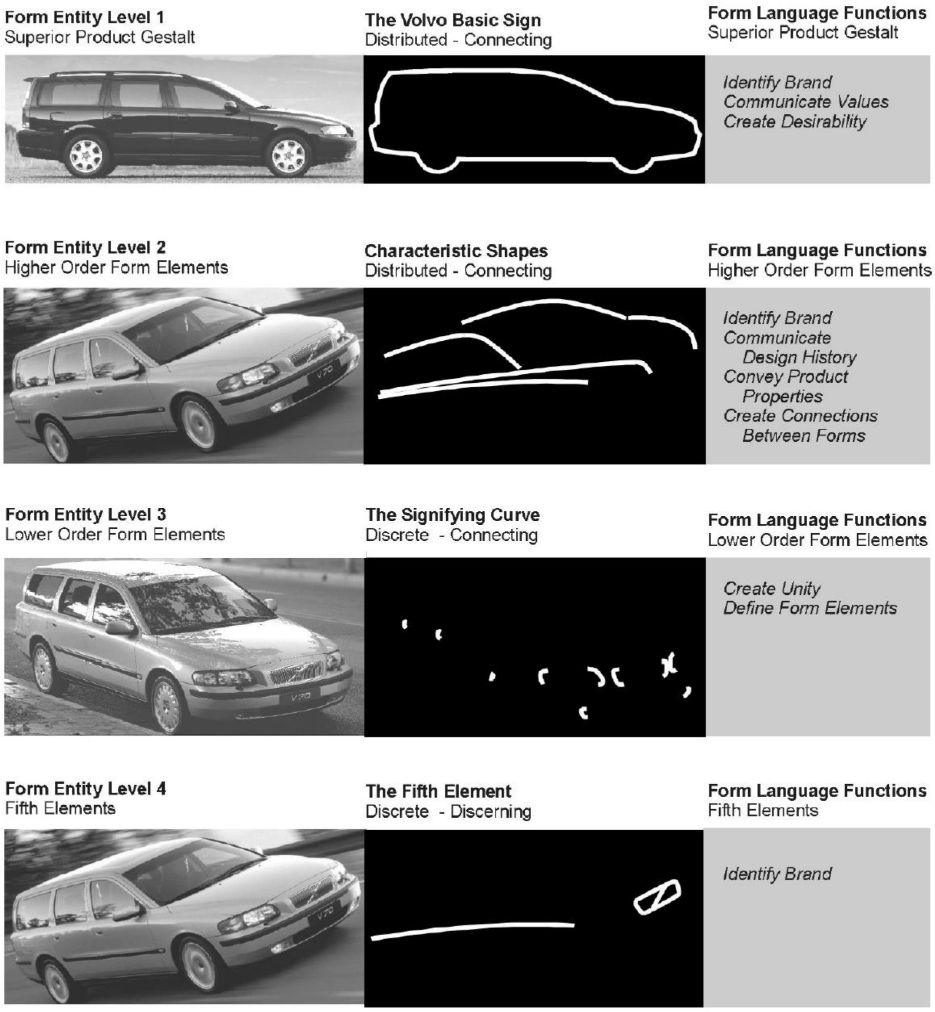


Figure 77 : Volvo brand form entities and form language functions (source: Warrel, 2001, p.195)

Both Automotive designers and Conceptual designers in the movie industry – sometimes with the same background studies - use a similar approach albeit more practical and less academic. A good example is concept designer and design professor Scott Robertson (2012) who refers to the definition of different design elements in the design process as "proximity based styling opportunities" and which can be organized as steps or "gates" in which the designer defines the form elements form a longer viewing distance, towards a closer, more detailed viewing vision. He argues that if all these steps are considered, the final design has a greater impact in the viewer (user). He organizes the different steps from the most global "gestalt" elements to the smaller details of the product is such a way (Robertson, 2012)[6]

- Silhouette – Proportion – Stance;
- Value Graphics;

[6] Adapted from Scott Robertson: http://www.carbodydesign.com/2012/12/design-lecture-proximity-based-styling-by-scott-robertson/ (Acessed: Aug.2017)

- Transitional Form;
- Line Graphics;
- Info Graphics (Maker, Model, On/Off, Advertising);
- Materials;
- Colour;
- Texture.

Animators who work in the movie industry also use the same kind of organization of form elements and a specific hierarchical structure. Companies like Pixar use these elements as a tool for storytelling. When we look at composition in animation motion pictures different elements are organized in such a way that they convey meaning and help tell the story. In this respect, animation professionals identify different levels of composition elements which can be described as[7]:

- Line: different lines communicate different aspects of the design and its function; express different qualities, have direction, weight, shape;
- Shape: primitive shapes are used to imply emotions in animation i.e., triangles are connected to action, speed, tension; circular shapes are connected to friendly, kindness; square shapes are connected to reliable and stable properties; character design develops from these primitive shapes in order to convey personality to the design of the characters;
- Space: composition is affected using space, free space, square space, etc;
- Motion: There are “motion lines”, helps the object appear its moving; there are “lines of action” which indicate pose and movement of the objects, in this case of the design;
- Tone and color: help lead the eyes in the objects; light values are typically associated with openness fun, light headed characters, dark values with mystery, sadness, ominous; low contrasts are calmer than sharp ones; colors can be similar (near the circular color) contrasting (more far apart) or complementary (in opposite sides). Helps set the emotion of the environment or character: cold colors can be relaxed and calm, but also more sad; warm colors could bring optimism and comfort.

These elements are combined in the scenes and used as tools which help establishing a narrative, describe the mood, convey personality to the characters, etc. Line, shape, space, motion, tone and color are also fundamental tools in conveying meaning in industrial design. Tone, color, textures, patterns, materials and finishes have become a fundamental asset in Almadesign studio’s services, applied to different transport design projects. The CMF – Color, Material and Finishing – department is hence an important part in developing the form language of the studio as the surface qualities of the projects- texture, pattern, color, tone - are a fundamental part of its Form Syntax and Semantics (e.g. the same form language can convey different meanings depending on its surface material, color, tone). Regarding the use of color in design sketching authors Eisnen and Koos (2014) state the following:

[7] Adapted from Khanacademy: https://www.khanacademy.org/partner-content/pixar/storytelling#visual-language (Accessed: Aug.2017)

People react to color on a visceral level (…) whether you embed your presentation (or design) in a color scheme or use color in a product, your viewer's first reaction will be largely subconscious, but will set the mood or emotion with which they receive the visual information. This also happens because colors may represent certain meanings, You need to make sure this associated meaning or emotion is an appropriate one (…) gold is understood to signify wealth virtually on a global level. White, however, could stand for purity, but also for death (or happiness) (…) Ask yourself: Is your audience generally global, Chinese, Muslim, young, old male, female, part of a subculture? (…) The context in which the color is displayed is also important. Orange in fashion may have a different meaning than orange if traffic or religion. A color can also be perceived differently due to the color (s) it is surrounded with (…) Color combinations can have an even stronger association than separate colors. For instance green and red representing Christmas, or black and orange for Halloween. (Eissen & Steur 2014, pp 103).

Synthesis of the chapter

The aim of this chapter was to establishing a theoretical framework around the investigation vector "Form Syntax", defined as the review of texts with focus on product form, and its different elements (shape, scale, size, rhythm, proportion, and etcetera) and the way they are developed into a specific Almadesign studio form syntax. The following objective was defined: To describe the Form Syntax elements in design, which could be relevant to defining the studio's own form language. They are the following:

- Form elements;
- Principles of visual perception;
- Principles of Gestalt;
- Principles of nature;
- Principles of surface continuity;
- Principles of organization.

The part was fully based on literature review. The main findings of this chapter would be the description of the most important princples regarding the development of a Form Syntax in a design context. The different elements studied provided a framework with which the researcher was able to analyse specific studio Case Study projects. In order to analyse the information in the most simple visual way possible, the following chart sums up the main findings.

Table 3 - Summary of Literature Review on Form Syntax

LITERATURE REVIEW: FORM SYNTAX	
Categories	**Elements**
Form elements	Line; Shape; Space; Value; Colour; Texture
Principles of visual perception	3 types of brain processing: Visceral (visual order); Behavioural (functionalism); Reflective (visual taste) Aesthetic preference: Order vs complexity
Principles of Gestalt	Pragnanz; Closure; Symmetry; Similarity; Proximity; Uniform connectedness, Good continuity; Experience; Figure/ground
Principles of Nature	Anthropomorphic form Golden ration Biophilia Self-similarity
Principles of Surface continuity	Surface continuity: Positional Tangent Curvature
Principles of organization (adapted from Robertson, 2012)	Silhouette Proportion and scale Value Graphics Transitional Form Line Graphics Motion / action lines Unity vs variety CMF

(source: researcher, 2017)

3 FORM SEMANTICS

3.1 *Introduction*

This chapter is about establishing a theoretical framework around the investigation vector "Form Semantics", defined as the review of texts with focus on the meaning of artefacts, on the semantic transformation in design that is the attributed of specific signs in objects and their interpretation by partners and clients. Toni Matti Karjalainen (2006) studied the processes of how meaning is formed and signs embodied in products, he refers to:

> *Product semantics deals with the issues of how meaning is formed and mediated as signs embodied in products. Semantic aspects refer to the representational product domain and thus regard products as symbolic communication. Motivated by linguistic semiotics, products can be partially comprehended in a manner similar to verbal language (Karjalainen, 2006, pp 58).*

The analogy to the spoken and written language has been referenced by numerous authors and it can be useful but also limited in its scope due to the major differences to the form language in the design discipline which is fundamentally a visual and physical materialization of artefacts. Nevertheless, the analogy can be useful to begin to understand the way different form elements – an alphabet of signs and symbols – can be manipulated by designers to convey meaning.

3.1.1 Objectives

The main objective of this section is to establish a theoretical framework around the topic of "Form Semantics", in order to define how a set of design elements and its composition – Design Syntax – can result in products which symbolically communicate.

3.1.2 Methodology

An initial list of authors and texts selected by the researcher and supervisors were analyzed in the light of the research vector, Form Semantics. As the research developed, new texts and references were added whenever considered relevant. The following topics were addressed:

- Theory of product language;
- Communication models;
- Attributing form elements;
- Interpreting form elements;
- Social and cultural associations.

Most important references used in this chapter range from the work of researchers at the Offenbach School of Design, Jochen Gros, Richard Butter (1994), Klaus Krippendorf (1994, 2006), Anders Warrel (2001), Toni Matti Karjalainen (2004), Borja de Mozota (2003), Eissen & Steur (2016), etcetera.

3.2 ***Form Semantics***

Product semantics deals with the issue of how meaning is formed and mediated in the form of signs embodied in the product (Karjalainen, 2006). Vhima (1995) refers to four dimensions of a product, which according to analogy on linguistics studies can be defined as Syntactics (deals with technical and and visual details), Semantics (what the product represents), pragmatics (product use) and material (deals with the materials use). For this chapter, we will focus on the Semantics aspects, as we have previously dealt with Syntax and will not be addressing pragmatics and materials in a different chapter, but included in the overall analysis of the form language.

> *Product semantics relies on an alphabet of signs and symbols, e.g. line, colour, texture, shape and form. By manipulating this visual alphabet, the designer repeats a similar process to the one found in the written or spoken language (Giard 1990, apud Karjalainen, 2006)*

The approach from this author is of course only looking at the Form Language as the attribution from the designer's part and the interpretation of users, but neglecting the fundamental aspect of interaction. He goes on to argue that:

> *The notion of form language originates from this use (…) Such a view, however, neglects the fundamental aspect of interaction. It supposes that, similarly to the language system, a specific construction of universally agreed signs exists that people interpret in a coherent manner, regardless of their background, culture or prior experiences. This view may be partly relevant for product semantics (…) I also suggest that a company and a designer can construct a specific set of signs and symbols that a larger group of perceivers would interpret coherently. This is, of course, the main purpose of strategic communication. However, the target group of this communication is always limited, and, even within this target group, the interpretations vary. Overall, the system of verbal language is precise – words refer (directly) to certain objects. The system of design is not this precise – meanings are more subjective. (Karjalainen, 2006)*

The author also explains, referring to McDonagh & Lebbon (2000), that a "product's 'language' involves the emotional bonds and cultural significance that contribute to a consumer's relationship with the product". This is, in effect, one of the great advantages of any creative field, in that it explores fields which are not precise but subjective and opened to different interpretations. This openness leads to different users not only perceiving objects in different ways but also, integrating them into their own personal experience, appropriating them and comunicating their own identity:

"In the article "Consumption and its consequences", Miller (1997) presents his work and announces 3 mains objectives: think of consumption not only as the act of buying, but as a fundamental process of building an identity[8]" (Rosales, 2002, pp 302)

In order to tackle this challenge, an approach using multiple referents was used, focusing on different topics on Design Semantics, specifically on the meaning of artefacts (in use, in context, in an ecology of objects), from the "client" / "user's" perspective. The term product semantics first appeared in the IDSA journal, Innovation in the 1984 article by Klaus Krippendorff and Reinhard Butter, considered the founders of the theory. In this article, the authors define the term as an "analysis of the symbolic qualities of things and a design tool to improve their cultural qualities" (Krippendorff and Butter, 1984)).

Around 1985, Michael and Katherine McCoy began teaching product semantics at American Cranbrook Academy (Detroit). In these courses, the designer was considered as the professional mastered the language of the products. Companies such as Phillips were influenced by this approach and achieved some success in their design strategy with the leadership of Robert Blaich and later with Stefano Marzano. Jochen Gros, of the Academy of Art and Design Offenbach in Germany, proposes an interesting theory of product semantics: "Theory of product language". (Krippendorff, 2006, pp 292).

So, let's look at how this model can help us in distinguishing specific semantic aspects on the form language of design which can be later on used as references in order to analyze specific Almadesign Case Studies.

3.2.1 Theory of product language

Product (or Form) Language, its syntactic and semantic aspects was addressed by the "Theory of product language" developed during the 80's at the HfG Offenbach school of Design. The objective was to address design theory and connect it with practice of product-language aspects. It was by this time that a lot of different human-machine interfaces were developing, particularly with the massification of the computers in workspaces and at home (personal computer). It was also a way for the design theory to address the questions already being posed by post-modernist architecture by Venturi (1972) and others and by designers such as the Italians with Ettore Sottsass's Memphis group (1982) and Phillipe Starck (1990). This approach distinguished different types of product functions, including signs and symbols, which could be interpreted as functional indications but also as references to styles, cultural or metaphorical aspects, with different degrees of openness for interpretation.

[8] HfG Offenbach school of Design is is an art and design university Germany where the "theory of product language" was developed primarily by Jochen Gros and Bernhard E. Bürdek during the 1970s and 1980s

“(…) the process domain applied to design aesthetics includes the manufacturing company’s intention to deliver the desired message to the designated customers. Such intent may consist of communicating the values of the product and the manufacturing firm; the properties, performance, qualities of the product; and to create desirability, pride of ownership, and excitement in owning the product. These design intents comprise the purpose of the product and are communicated to the user during the use-process through the aesthetic appearance of the product. During aesthetic form development, these intents are transformed into functions driving the aesthetic development of the product. Such statements of purpose, describing aesthetic design intent, can be considered functions of the form, since they drive the development of form solutions by help of certain aesthetic principles and means; they do something in the eyes of the beholder. In the function domain, these functions fulfil the stated aesthetic form purposes of the product, such as identifying the brand, creating harmony and consistency in the form, expressing power, speed, elegance, etc.” (Warrel 2001, pp.189)

The theory of product language was developed by Richard Fisher and Jochen Gros, and includes a “functional” decomposition that includes the different functions of a product, from practical to language functions. Figure 78 depicts the theory’s general approach.

“Gros presents a functional decomposition that divides functions of a product into “product language functions” and “practical functions.” Product language functions fulfil aesthetic design intent, while practical functions include, e.g., transforming, structural, ergonomic and semantic functions, Warell In the model, according to Gros the “indicating function” of the sign delivers objective facts about the product such as information about product type, while the “symbol function” adds subjective, associative and interpretive meaning to the product sign. Compared to the semantic functionality by Monö which treats describing, expressing, exhorting, and identifying functions, product language functions are related to visual appreciation, and are not primarily associated with product understanding or use of the product.” (Warrell 2001, pp 190)

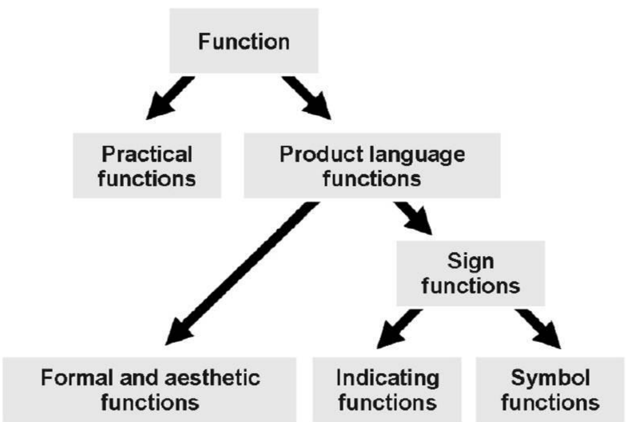


Figure 78 : Gros’s Theory of Product Language (source: Warrel, 2001)

Gros presents this approach in which there is in fact a decomposition of function in a product into "practical functions" (related to the functionality of the product) and "product language functions" (appearance of the product). The product language functions are themselves decomposed in sign functions (which include indicating functions and symbolic ones) and formal and aesthetic functions. Warrel explains:

> *"Product language functions are of 2 types. The sign functions function by way of the semiotic sign. They refer to the practical functions and serve purposes of 'self-explanation' of product properties. They function through signs, which point to properties and symbolic representation of the product form, i.e., they represent semantic functioning of the product. The indicating function provides 'factual' information about use and product properties, associating the product with a group of products. The symbol function provides "qualitative" information, which is dependent of, e.g. subjective, personal, and cultural interpretation of the user. The formal and aesthetic functions include the non-semantic part of product functionality, associated with the visual aesthetic content of the product" (Warrel, 2001, pp 73).*

This approach should be viewed in different perspectives. From a designer point of view, it probably makes little sense to break up and divide all this functions into separated blocks, as they are not though of as separate elements. But is some cases, as in the case of automotive design, where technical functions are sometimes already defined, designers can sometime be pushed to just design the styling part of the solution, hence focusing only on the product language functions. But even here, it is difficult to consider such a difference, as all design and form decision determine some kind of functional and practical change (e.g. a line on a door opening affects the ergonomy of use). Dagmar Steffen (2010) explains and comments the model:

> *"In this model, Gros makes a distinction between the practical functions of a product (and various others such as ergonomic, economic, ecological functions) on the one hand, and the formal and communicative aspects, the so-called product language functions on the other. Analogous to the differentiation commonly deployed in languages studies between syntax and semantics, Gros subdivided the specific object of product language into formal aesthetic functions, i.e. those aspects that can be observed irrespective of the meaning of their content – and the semantic functions. Defining the latter as the bearers of meaning (…) he then proceeded to differentiate between sign functions or indication functions and symbolic functions in this group (…) Indicating functions (…) enable the product category to be identified. Furthermore, indicating functions conciliate technique and human beings; they visualize and explain the various practical functions of a product and how it should be used. Thus, they play an important role concerning recognition, usability and self-explanation of products." (Steffen, 2010, apud Vihma, 2010, pp 87-88).*

The various subdivsions of the model are further explained with specific examples in Figures 79-81:

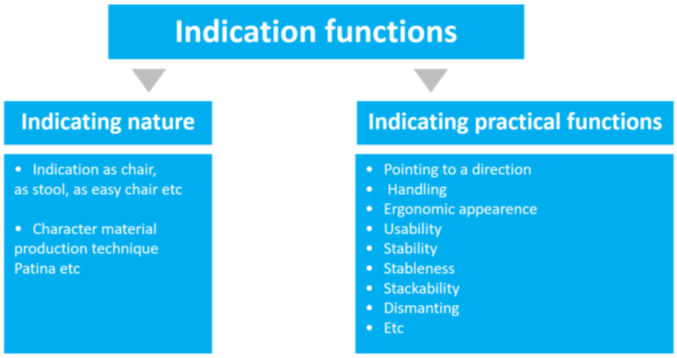


Figure 79 : Gros' Theory of Product Language: Indicating Functions (adapted from Steffen, 2004)

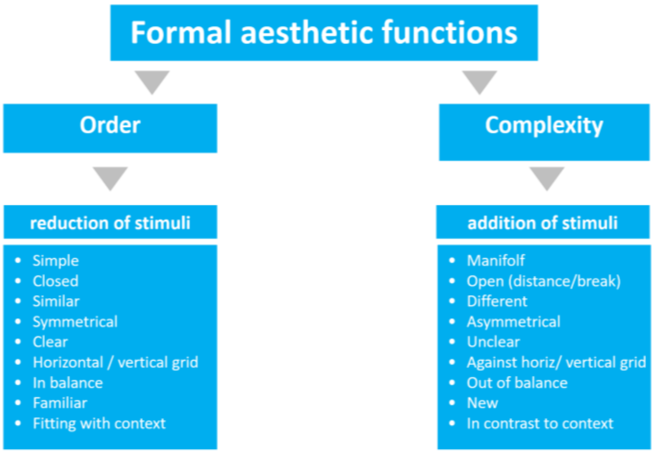


Figure 80 : Gros' Theory of Product Language: Formal Aesthetic Functions (adapted from Steffen, 2004)

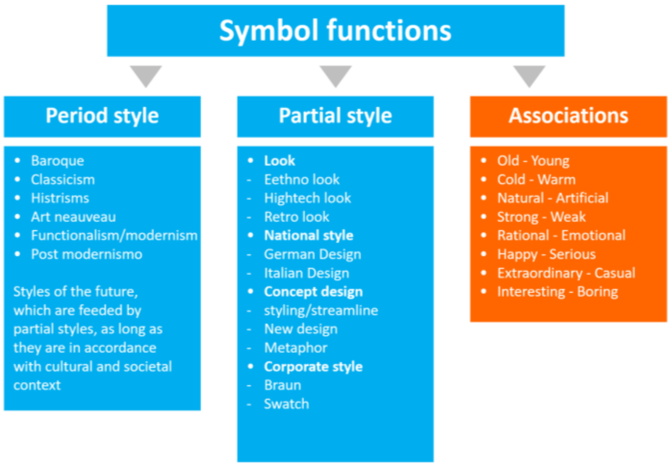


Figure 81 : Gros' Theory of Product Language: Symbol Functions (adapted from Steffen, 2004)

The approach of this theory is critized by Klaus Krippendorf (2006) who published the "Semantic Turn" in 2006 in which he refers to the limitations of the theory:

> *"The chief objection to the theory of product language concerns its conception of language as a system of signs and symbols. This premise is that products, their makeup and composition, can be designed to tell their stories, stories about their mode of production, purpose, history, use, and location in time and in society (…)Technological artifcats, just like texts, say nothing and mean nothing on their own, except what their stakeholders grant them to mean. Products cannot speak a language, humans do. Adopitng this theory of language diverts attention from the human use of language – in everyday life as well as in collaborations among designers – to abstract accounts of the properties of products." (Krippendorf, 2006, pp 293)*

Krippendorf and Butter propose to focus on the the context of use and look and the problem as one of having different stakeholders in a complex system from which the design and use of artifacts produces meaning. Figure 82 presents a diagram, published in their 1984 article which depicts a "designer whose circumstances realistically restrict him to be a mere contributing communicator, albeit a very important one" (Krippendorf and Butter, 1984, p.6). The diagram shown helps us understand that there are a lot of stakeholders involved, technical, marketing and other constraints until the product gets to the final user and then, the are the individual users' interpretations which the authors refer to as the "circular process of their involvemnet with the designers' products" (Krippendorf and Butter, 1984).

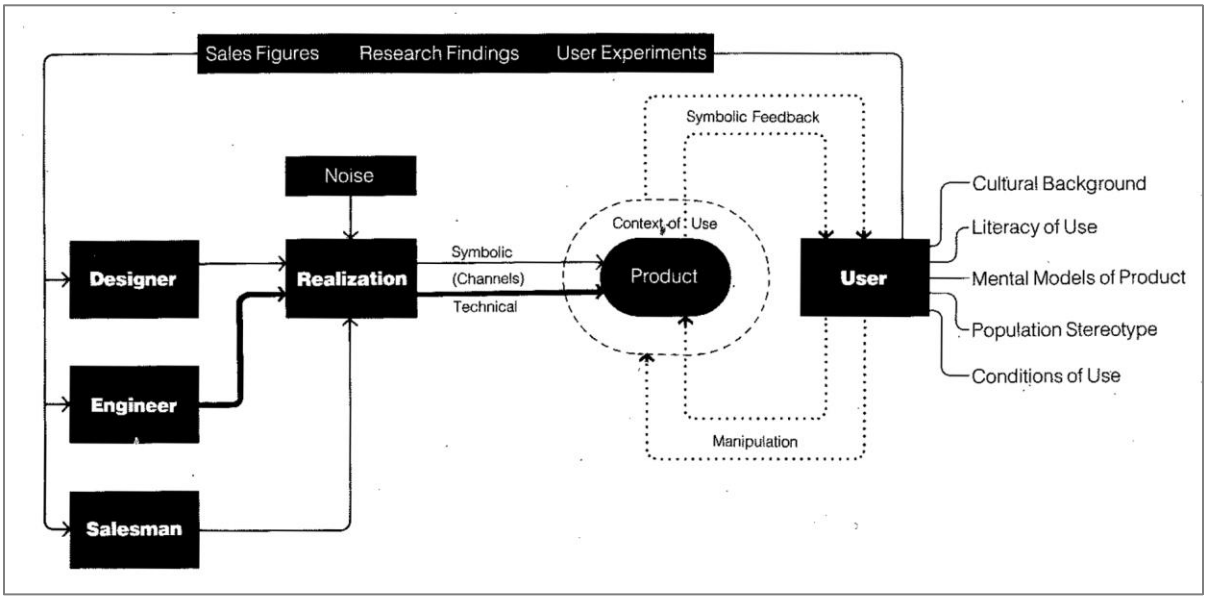


Figure 82 : Product semantics in the design and use of artefacts (source: Krippendorf and Butter, 1984)

Nevertheless, this research considers that although Krippendorf is right in his critical approach towards a theory which focuses on the “abstract accounts of the properties of products” (Krippendorf, 2006) these are, in fact the features that make the theory a powerful tool for analysing the Form Language of the studio, from an empirical point of view. Van Onck (2000) explains this principle by analysing the difference between theoretical concepts and practical design daily activity:

> *“In pure Peircean thinking the formulation of design language should derive from design in practice, from semiosis, from the way signs are formed and perceived and not, vice versa, from the combination of theoretical concepts in a general reference frame. Not starting from a speculative top, as in the field of perception theory, psychology, sociology, information theory or linguistics, but from the pragmatic bottom of daily design activity and its impact on users.” (Onck, 2000, pp 3)*

In the daily activiy, designers work for different clients and in transport design, product and interiors much of the work is related to specific brands which have specific design formats. Warrel (2001) and Karjailainen (2004) address semantics in product design, as a concept associated with brands and the concept it defines as "semantic transformation". The latter author focuses on the attribution of meanings to products, and on their transformation (semantics) into "visual cues" (in the original "design cues"). Using the car design (Volvo) and the design of mobile phones (Nokia) as two case studies, the author analyzes the methodology used by designers to transform into material proposals (automobiles and mobile phones in the case in question), qualitative expressions and conceptual ideas that represent a brand (the design philosophy of the brand - its DNA) which could eventually be recognized by the consumer. These are complex questions, indeed, brands need to be constantly in communication with their customers so that there is the construction of a common language system, for the comunication of brand values though design (and other means) can effectively be developed. The author allows us to recall that while the verbal language system usually has great precision, the reference system in the design is very subjective, which makes the philosophy of the brand only to be understood by some. Nevertheless, this materialization, when it exists, is achieved through a combination of implicit and explicit characteristics:

> *“Implicit (qualitative) references, or combinations of references, are not readily distinguished but implemented with the intention to be inherently perceived and recognised. They involve merely inherent associations - denoting the generic ‘design philosophy’ of the brand - that are related to the overall reputation, image, and appreciation of the brand and its products. Whereas explicit cues embody references that everyone can see, implicit cues comprise references that cannot be distinguished but, when used, ‘make sense’. If (implicit cues) fail to communicate the brand character, recognition is not supported.” (Karjalainen, 2007, p.6)*

Another author refines this model by associating the concept of “comunication functions” which he divides into “space strutcturing” and “sign carrying” design features or form elements. (Muller, 2001 apud Warrel, 2001). Overall, both the sign functions and (formal) aesthetic functions should be addressed by this investigation, in order to help define Almadesign Form Language.
Although the roots of semantics in design date back to 60 's at the HfG in Germany, it was near the end of the 70's that the study was deepened with the critical approach towards the "functionalist"

models. The search for a universal language, without cultural references, had set the pace of the "International Style" in architecture - a concept of Philip Johnson and Henry Russell Hitchcock – where “From follows Function”. But the removal of consumer needs and cultural references from each market, among other factors, led to a paradigm shift as a “counter-revolution” - the study of semantic aspects in design.

3.2.2 Semiotics

Eissen and Steur (2014) refer to visual semantics directing their attention towards the designer’s understanding of such principles in order to communicate through drawings and sketches his/her design ideas. They argue:

> *All visual information appears to refer to one meaning or another. This meaning will not be the same for everyone, as it depends on factors such as age, profession or cultural differences (…) Visual semantics is a field of study that investigates the connection between visual signs and the things to which they refer, i.e. their meaning. (Eissen & Steur, 2014, pp 91).*

They go on to argue that visual signs are learned throughout your life and are learned through a set of “conventions and codes”. Cultures and different people can have different conventions and they can change over time. They refer to the terms used in semiotics, which they explain as following:

> *“Archetype: we call something archetype, if it embodies the fundamental characteristics of something. It is like a prototype of something, a ‘standard example’ or ‘basic example’, from which others are copied. It is an image that is universally present in individuals. Archetypes are meant to be universally clear and easily understood. In traffic signs, you will find various archetypical representations (…) around the globe (…) but they will generally be understandable. These archetypical images will slowly change over time, for instance, as its referent evolves due to (technological) innovation. Another area in which images are used to transcend cultural differences is that of the Internet icons; universally understood and independent of language.” (Eissen & Steur, 2014, pp 91).*

If a new product or idea is unfamiliar to a user, visual analogies or metaphors can be used to make it more “understandable”. This is the case with the famous “desktop” metaphor in computer HMI for the last 30 years. The screen of the computer is “still” compared to a desktop where you put your “files” and “folders”, them too visual analogies for the computer interface. When referring to semiotics, two authors are best known for their approaches, Charles Sanders Peirce (1867) and Roland Barthes (1957). Eissen and Steur refer to three ways signs can represent their referents:

> *“Iconic relation: (…) the sign resembles what it actually stands for. It is a figurative relation; you can recognize the shape of the subject (…) In general, pictograms are an abstraction of reality used to convey a message in a simple and clear manner without language. Indexical*

relation: In this case, the sign refers to something in an indirect manner, for example by association. A crystal refers to snow and a thermometer to temperature. But also many Internet pictograms, such as the envelope which stands for email, but visually refers to regular mail as we (learned) know it. Symbolic relation: These types of signs have a non-figurative relation to their referent; the visualization does not mimic reality. Instead, they are based upon agreement or habit; based on conventions." (Eissen & Steur, 2014, pp.92).

In order to visualize these issues, some visual examples are useful to further clarify these definitions, such as the Figure 83 in which different types of Signs represent different referents (e.g. phone, e-mail or recycling)

Figure 83 : Types of Signs: Icon, Index and Symbol (adapted from Eissen & Steur, 2014, pp.92)

But Peirce also defines the relation between Sign and its Referent and the Interpretant and their context. Eissen and Steur exemplify:

"Semiotic moments: Peirce also spoke of 'semiotic moments', stressing the fact that there is a 3-fold relation to be identified among the sign, its referent and the interpretant (he/she who interprets). He thus pointed out that the context in which we perceive a sign is also very relevant. We are faced with traffic signs in traffic, for example, where they have a clear and understood meaning. Some relations work better in certain contextual situations. Of course, an iconic relation can only be made when the viewer is acquainted with the referent it stands for. However, usually – especially in communication with people of one's (sub)culture – iconic signs are the easiest to understand. This is why so many of them are used in the Internet. Symbolic signs require the most (insider) knowledge to be understood (…) (designers should) be aware of the levels of semantics indicated by Peirce. When using indexically or even symbolically related signs, be sure that your target audience shares the same conventions regarding the meaning of these signs" (Eissen & Steur, 2014, pp 103).

We can conclude that this approach is very much in line with communication design and specific HMI (Human machine interface) design, which is becoming very important in specific areas of design such as transport design, and automotive design. These areas, also called UIX – User Interface Design – have become an important part of an automotive design studio together with exterior and interior design departments in the digital Age. We can also conclude that the whole communication process between design and user is essential to understand how the meaning is conveyed and then understood. Perhaps even more important, the approach of semiotics in an area such as transport design exteriors and interiors is the approach of Roland Barthes (1957), French philosopher who approached semiotics from another point of view:

> *(Roland Barthes) distinguishes 2 different kinds of meaning: denotation, which is the explicit or literal meaning, and connotation, which is a commonly understood cultural or emotional meaning. One could say that denotation is objective and connotation is more subjective (…) Connotations are subjective, different for everybody, and usually classified as either positive or negative. (Eissen & Steur, 2014, pp.104).*

He furthermore distinguishes between levels of Denotation and Connotation (primary and secondary). So, overall, we would have four levels of meaning for a determined image (or design) being:

- Level 1: primary denotation: common shared knowledge;
- Level 2: secondary denotation: objective, but only some people know it;
- Level 3: primary connotation: negative or positive, different for everyone;
- Level 4: secondary connotation: very specific knowledge or thought of knowledge about the object;

Roland Barthes in Mythologies (1957) states that objects and images not only mean their basic function, but also reveal a "meta-meaning." His analysis focuses on semiology based on linguistics. Jean Baudillard (1969) also focuses on semiology, referring to the connection between social life and symbols in the products in the book "The system of objects" in 1969. Rune Mono (1997) is another author who looks at the issues of semiotics in design. Mono teaches semiotics in product design and his book "Design for product understanding" aims to develop a possible language for designers, based also on the theories of Pierce and the German linguist Karl Buhler (Hlelm, 2002).

The study of semantics in product design gained special prominence in the early 1980s, especially with the success of the Memphis group. It is at this stage that several articles are published and conferences and workshops are organized, such as the conference at the University of Industrial Arts in Helsinki in 1989, which brought the contribution of several designers. Reinhart Butter (1989) then suggests a practical approach to the questions of product semantics defined in three steps (“The

Practical Side of a Theory"): Choice of the character of the product; Attribute listing; Search for visual expressions of these attributes. This is a process which is used in many design studios, where the clients' brief is interpreted by the designers through the "choice of character" with specific "attributes" and then transformed into "visual expressions" of these attributes through the use of moodboards. The author also mentions the "aesthetic honesty" in design: the expressive and semantic attributes of the products must be equal to the factual ones. Other authors, such as Hans-Jürgen Lannoch (1989), refer to the issues of "semantic transference": how can we define the character of a product and then materialize it through the use of language (e.g. through adjectives that define qualities) in three-dimensional shapes. This question, which is fundamental in the definition of branding processes, is presently a study theme of several scholars such as Toni-Matti Karjalainen (2004).

Horst Oehlke (2001), Susann Vihma and Seppo Väkevä (2009) are also studying communication through product design and are mainly concerned with semiotic issues, with a less practical content and hence a more difficult application to practical project methodologies in design studios. These authors study the semiotics by subdividing it into semantics (which studies meaning), syntactic (which studies grammar), and pragmatics (which studies usage). Susann Vihma (2010) proposes that in the products coexist interrelated dimensions: the material (which depends on the materials used in the construction of the objects); the syntax (which depends on the technology used and the type of Form Language that comes from it); the semantics (which represents the product in question, what functionalities it communicates, in which group of objects it belongs - ecology of the product). Based on these principles we will try to link these various dimensions in Communication models.

3.2.3 Communication models

Jacques Giard (2016) recalls that communication is based on models with Emitter, Receiver, Message and Feedback. This means that from the time the designer incorporates some kind of message in an object only when the feedback corresponds to the message sent we do understand that there was a communication without noise. We find that this is a proposal similar to that of Butter (1984) (also from Krippendorf), that is, the role of designers is not only to design the "message" (product) but also to verify if the message they want to convey is to be understood by the receiver - if there is a correct feedback (downstream of the process). This "verification" places the user as the focus of the communication problem. And, of course, this can happen on the different levels of the Form Language functions, from symbolic, indicative and form / aesthetical functions. Krippendorf and Butter (1984) present a simple communication model stating the relationship between Sender, Message and Receiver (Figure 84):

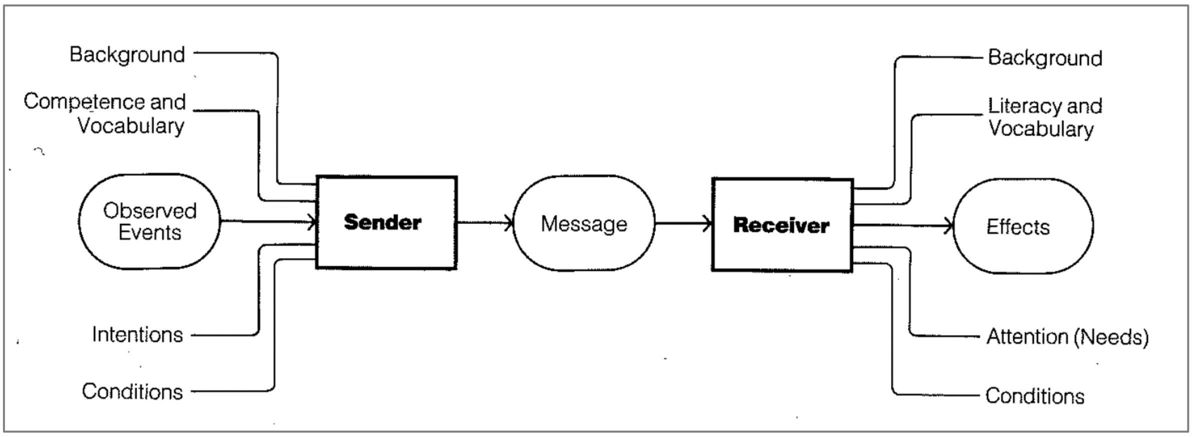


Figure 84 : Communication process (source: Krippendorf and Butter, 1984)

The authors consider of the upmost importance the fact that the user acts on the product and tries to make sense of its form, thus trying to produce meaning. Borja de Mozota (2003) connects the communication model to consumer behavior, focusing on the relationship between the designer's intentions and users (consumers) responses, psychological, emotional and behavioral. The following diagram, Figure 85, explains design and consumer behavior using the following diagram, adapted from Peter Bloch work:

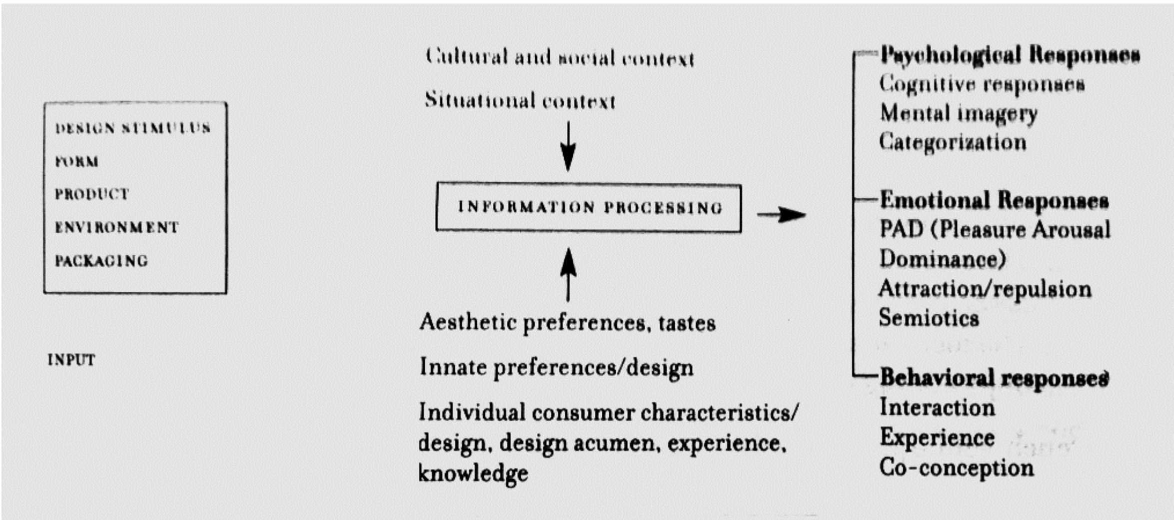


Figure 85 : Design and Consumer behaviour (adapted from Bloch) (source: Mozota, 2003)

Mozota focuses a lot of attention in the way perception and information processing affect the way consumers react to products, as explained in the diagram. Peter Bloch (1995), focuses on the "whole lifecycle", that is to say, from design goals and constraints which condition the development of the product form, to the moderating influences between the products development and its use, and finally, to the psychological response to product form depicted in Figure 86:

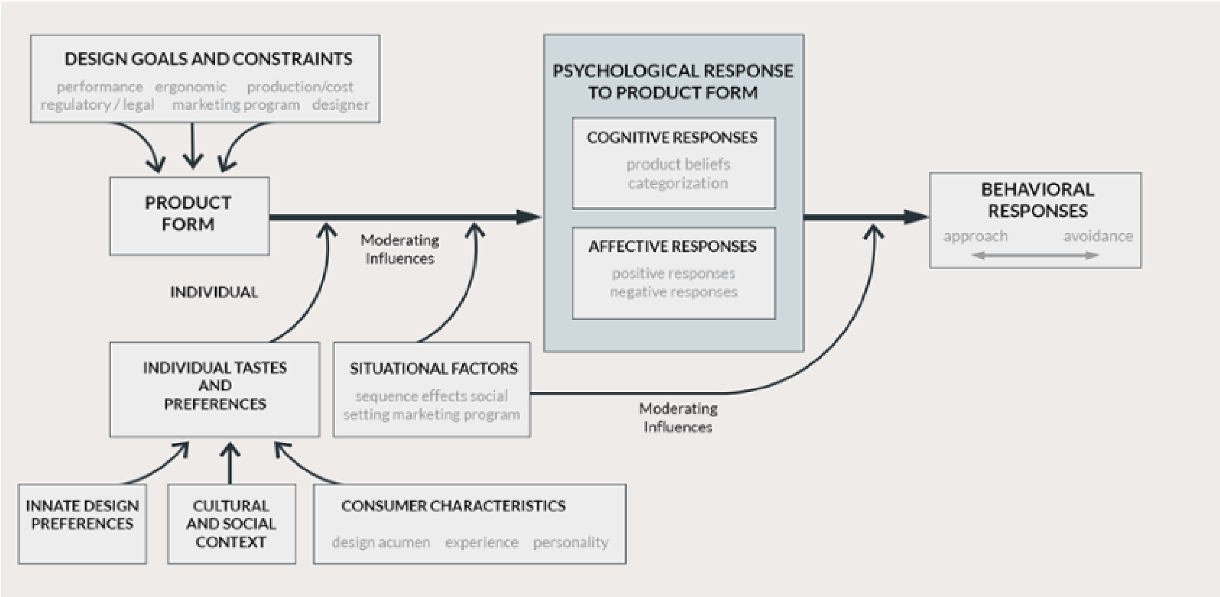


Figure 86 : Psychological response to product form (source: Peter Bloch, 1995)

The author explains the model, starting by the role of the designers in defining the product's form by using different elements and a specific organization which aims to achieve a particular "sensory effect":

> *"As used here, a product's form represents a number of elements chosen and blended into a whole by the design team to achieve a particular sensory effect (Hollins and Pugh 1990; Lewalski 1988). Designers make choices regarding characteristics, such as shape, scale, tempo, proportion, materials, colour, reflectiveness, ornamentation and texture (Davis 1987; Kellaris and Kent 1993). Designers also decide how to mix these elements and determine the level of congruity that should exist among them (…) Given the purpose of the product, its target market, and its desired performance specifications, the design team attempts to create a product form that will be successful. Complicating matters, however, is the presence of outside constituencies, such as legal counsel and government agencies, that also contribute to what form a product should take (…) Production processes and manufacturing costs also influence the form of a product (…) In developing a product's form, designers also provide constraints and objectives of their own. In particular, designers can select or modify form elements to fulfil professional goals and desires for self-expression (Lawson, 1983). In other cases, a form may be developed with the constraint that it shares certain characteristics with previous projects from the designer or design house (Nussbaum 1990b). Thus, the goals of the individual designer or design team may conflict with other constraints, adding to the overall*

complexity of the task. For example, a designer may seek a greater level of novelty and impact in a product form than the market is willing to accept." (Bloch, 1995, pp17-19)

Further on, the author argues that regarding the consumer response and its psychological responses to Product Form the same form can elicit different responses from different consumers in different psychological levels (cognitive, affective) but also social (consumer's beliefs about the product and the brand positioning). He argues:

"The product form, once developed, may elicit a variety of psychological responses from consumers (…) these psychological responses include both cognitive and affective components (…)Product form may create or influence beliefs to such characteristics as durability, dollar value, technical sophistication, ease of use, sex role appropriateness, and prestige. Designers often choose particular form elements to proactively encourage the creation of desirable effects (Berkowitz 1987) The form of a product influences how the product is categorized within and among product classes (…) perceptions of a product's form evoke several affective responses from consumers. In some cases, product form perceptions can lead to a moderately positive response such as simple liking, or they can evoke stringer aesthetic responses similar to those for works of art (…) managers must also recognize the possibility of negative affective reactions to product form perceptions (…) The intensity and valence of affective reactions to a product are a function of its perceived form (…) behavioral responses to design can be described as either approach or avoidance (…) Individual design tastes are a function of innate design preferences, cultural and social context, level of design acumen, experience with design, and personality variables" (Bloch, 1995, pp 20-24)

The author finally explains the relationship between marketing and communications strategies around a product, and how they affect the user's perception and psychological response:

"Product reactions can also be shaped by the marketing program that surrounds the product. The portrayal of the product in advertising may complement and enhance the psychological responses to the product form itself (…) Another potentially important moderator of consumer reactions is the manner in which distributors display the product (…) The relationship between product form and psychological responses to that form is moderated by the marketing program that surrounds the product". (Bloch, 1995, pp 20-24)

Another, simplified model, is proposed by Crilly and Clarkson (2010) who explain the communication model (Figure: 87):

The research literature of many design disciplines describes designed artefacts as "texts" that are written by designers and read by consumers. This simple analogy emphasizes that designers have intentions for how artefacts are to be interpreted and that consumers form their own interpretation as they interact with those artefacts (…) Such models emphasize that designers have the ability to influence consumers' interpretations; they all emphasize that interpretations may differ from intentions. Many factors influence the construction of meaning (…) Most of the existing communication-based models of design were developed to *represent specific issues of interpretation, including usability (Norman 1988, 190), branding (karjalainen 2004, 53) and quality (Forslund et al.2006). (…) Like many of the models that precede it, this synthesized model depicts the designer as communication with the consumer through the medium of some designed artefact"* (Crilly & Clarkson, 2010, apud Vihma 2010, pp 131-132)

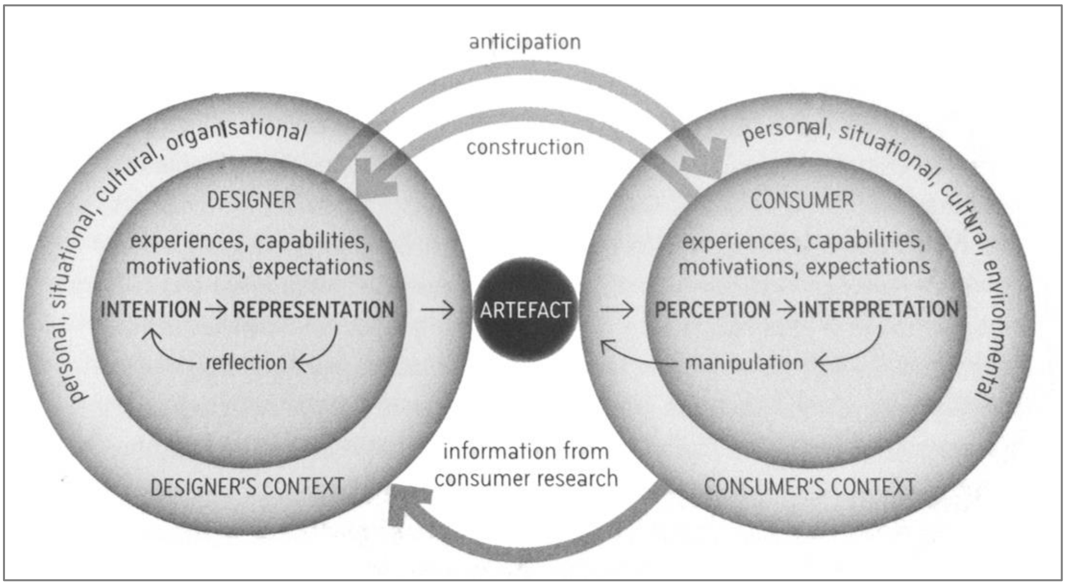


Figure 87 : A simplified integrated communication-based model of design (Crilly and Clarkson, 2010)

"The basic spine of the model runs from left to right. The designer is depicted as holding some intention for how the artefact should be interpreted and constructing provisional representations of the artefact, e.g. sketches. During the design process, the designer may continuously reform these intentions as she reflects on the representations drawn (Shon and Wiggins, 1992). Such representations inform the process by which the artefact is produced, an artefact which is taken to be, at least partially, a manifestation of the original (or emergent) intention" (Crilly and Clarkson, 2010, apud Vihma 2010, pp 131-132)

This is interesting to analyze and to relate to Almadesign own process of implementing the conceptual process, in which the sketches developed are shown and presented to the creative directors and then refined and shown to the clients. From here on, a lot of iterations occur in order to build the actual product and it is expected that the concept sketch visualization first presented and chose by the client could be very much the same one. This obviously carries a lot of technical, production, maintainability, technological problems, as not always what is designed and (and hence intended to be communicated) can be technical realized in a feasible cost effective way. This is the process the design and engineering teams have to go through, hopefully not losing the initial "look and feel" and hence the "main message" to be developed and communicated to the final user. The authors go on to explain the model, which we are intending to use as our main reference in this investigation:

> *As the consumer (user) is exposed to, engages with and interacts with the artefact, her sensory perception and interpretation may relate to specific details and features, to the entire artefact, or to how that artefact relates to its surroundings. However, the consumer's interpretation is not static; as she manipulates the artefact it's state changes and this change must then be perceived and interpreted (…) Furthermore, the consumer does not just manipulate the artefact, but also the environment within which those artefacts are situated. As the consumer changes the artefacts' environmental conditions, or moves the artefact to some new environment, her perceptions and interpretations may change (Krippendorf and Butter, 1984)." (Crilly and Clarkson, 2010, apud Vihma 2010, pp 133)*

This contextual aspect is fundamental in interpreting the communication aspects of these models. In fact, we have a lot of examples we can cite in which the context is of great importance. A simple example maybe in the dimension/scale properties of a certain design, as a car. A car in Europe, based on the average dimensions of the cars and of the public roads, could be considered as a "large" car. If you compare it to the average dimension in the US (cars and roads) the European car looks small and immediately loses importance and symbolic status as it stands as a "little" object compared to the US cars. The authors go on to refer the importance of the processes of design development and the different interactions between designer and client:

> *"Although the model separates designer from the consumer, it need not be taken to imply that either party is unware of the other. On the contrary, during the design process designers may work in ways that are informed by their anticipation of who will interpret the final artefact."* (Crilly and Clarkson, 2010, apud Vihma 2010, pp 134)

Almadesign designers and clients work in close partnerships, in which the different concept designs presented are discussed and improved over several meetings. Hence the communication process is developed over time but usually does not include final users but clients and partners. This is true for most of the transport products, where the studio's client is actually the OEM (e.g. bus / coach manufacturer) and not the final passenger. The manufacturer's client is a bus fleet operator (such as National Express in the UK or Carris in Portugal) and the actual final users (the passengers) are the operator's client. So, all these aspects have to be taken into account in the model of communication.

Another important aspect of the communication model when applied to Almadesign is the fact that the team of designers is composed by different designers which can also have different intentions. From the initial brief, specific design and communication intentions are issued. But each designer can have its own interpretation of these, although typically the top management is always involved in the process. Crilly and Clarkson refer to these aspects:

> *Like many of the models that precede it, the synthesized model presented (…) depicts a designer with an intention engaged in defining or producing an artefact. However, in any large design project we might be interested in the potentially multiple intentions of the*

potentially multiple designers that comprise the design team. More generally, the collective intentions of all the agents that comprise an entire institution of production might be considered, especially those involved in communication-oriented activities such as marketing (…) Any of these artefacts exists in the context of, for example, its predecessors, competitors, and supporting services, all of which relate to each other in many complex ways (…) Again, even for a single consumer, some single permanent interpretation of the artefact is unlikely and instead, a collection of complex, conflicting and evolving interpretations may be expected (…) will probably evolve over time. (Crilly and Clarkson, 2010, apud Vihma 2010, pp 136)

Another point is that in representing the relationship between the designer's intention and the client (or user) interpretation there are also other means of communication other than the artefact. As we have already referred to, the design team might be involved in communication through sketches, renderings, illustrations etcetera. The authors refer to this:

"Firstly, the process of communication that precede the production of the artefact are omitted even though that artefact often results from many negotiations that surround its meaning. Secondly, the process of communication is seen to end with the consumer's interpretation of the artefact, whereas this interpretation may actually be only one stage in a process by which meanings are continually formed and reformed as the artefact enters society (Whyte, 2006). Therefore, when interpreting or modifying the models, consideration should be given to acknowledging and presenting the way in which the communication processes precede the designers' intentions and follow consumer's interpretations." (Crilly and Clarkson, 2010, apud Vihma 2010, pp 139)

It is also interesting to note how other authors, such as Karjalainen (2004) introduce the concept of "semantic transformation" and "semantic attribution" (or interpretation) when studying cases form the automotive industry and product design industry. He focuses on the process by which certain brand features can be infused in a product as a specific form language, sometimes called the brand DNA. He states this process is fundamental when managing a big portfolio of products (as with the automotive industry) where each product is different as it is segmented for a specific market / client, but at the same time should carry enough references to the brand that it looks "a part of the family". Figure 88 depicts the model which the author explains as:

"From the company point of view, anticipation of consumer perception and interpretation is crucial. The customer's past experiences with the brand as well as their capabilities and motivations have to be assessed and projects on their probable expectations regarding the new product. The relation between brand strategy and product design is then established through acts of "semantic transformation" (Karjalainen, 2004). Through these acts, qualitative brand descriptions – the product character – are transformed onto value-based design features. These value-based features generate the intended meaning of the product. From the consumer point of view, the reverse process of "semantic attribution" occurs, when certain meanings are attributed to the design features." (Karjalainen, 2010, apud Vihma 2010, pp 189)

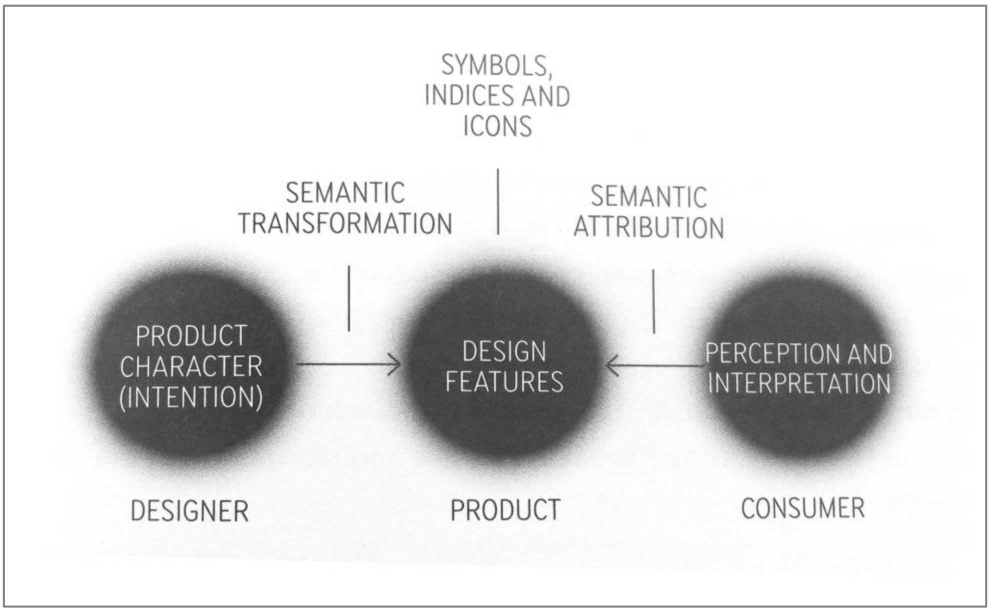


Figure 88 : The processes of meaning creation (Karjalainen, 2010)

According to the author, it is the designer's job to go through the semantic transformation processes, transforming brand description into form elements (value-based features) which can potentially generate an intended meaning. Marketing and communications can further enhance the process and avoid distortion between the "transformation" and "attribution" processes:

> *"In an ideal, strategically controlled situation, the meanings transformed by the company (designers) equal those attributed to the product by the consumer. If inconsistencies between the intent and the interpretation occur, they can result from two major "distortions". Either the designer fails to encode proper meanings into the product, or the user fails to decode them correctly.(…) Potential distortion in decoding can be a consequence, among other things, of the user's weak experience of the product category, inconsistent support information, or differences in cultural and social contexts (…) certain visual features entail rather complete attribution. Such features can be inherent either to human nature or to culturally established codes (…) the features communicating dynamism (in cars, e.g. sharp bone lines, forward stance, etc) typically include indexical references, as they involve a direct, almost automatic interpretation that is often subconscious. It has, however, been argued that brand-specific features typically involve strong symbolic references that are based on a web of meanings deriving from the interpreter's prior experience and are culturally and socially based (e.g. BMW kidney grille element) (…) Since not all design feature have the potential of generating complete attribution, consumers must be provided with the means of understanding the meanings in order for them to decide the intentional messages the company has designed into the product. Marketing communications and other promotional media can help the company avoid inconsistencies and distortion between the transformation and attribution processes (Karjalainen, 2010, apud Vihma 2010, pp 189-191)*

3.2.4 Social and cultural associations

Krajalainen (2010) clearly explains the complexity of the attribution and interpretation of product semantics or in the Form Language of a product. By itself the product and its form features do not contain any embedded meanings, they are always interpreted and not isolated. In this sense, the cultural and social backgrounds and situation of the user will help shape the way the semantic interpretation occurs.

> *(…) the products or the design features themselves do not contain any embedded meanings. The meanings are co-determined in the interplay between product representations and the interpretation context. Design cannot communicate in isolation. It can steer the company's brand strategy and function as a central part of it, but it always needs to be synchronized with a number of other communication features. (Karjalainen, 2010, apud Vihma 2010, pp 193)*

According to Lewalski (1988), the most complex level of aesthetic values is related to social, cultural, and market factors at a particular time and place (Lewalski, 1988). These values are extremely important because they prevail, in most cases, over the previous ones (such as visual simplicity and functionality). Baxter (1995) also mentions that products always have a cultural and symbolic quality that influences aesthetic preference because they appeal to the personal and social values of the user. This leads to cultural factors usually overlapping other elements of perception factors (Baxter, 1995). According to different types of information processing, as referred to in the chapter about Form Syntax, the different perceptions (visceral, functional, reflexive) are increasingly complex and the latter overcomes the first. Adrian Forty (1986) addresses these questions, stating that the cultural mindset of a certain time, its context, the relationship between economy, industry and people help build the meaning:

> *"Historians of design have often tried to get around the problem by attributing the changes to some sort of evolutionary process, as if manufactured goods were plants or animals. Changes in design are described as if they were mutations in the development of products, stages in a progressive evolution towards their most perfect form. But artefacts do not have a life of their own, and there is no evidence for a law of natural or mechanical selection to propel them in the direction of progress. The design of manufactured goods is determined not by some internal genetic structure but by the people and the industries that make them and the relationships of these people and industries to the society in which the products are to be sold." (Forty, 1986, pp 8)*

The author exemplifies his point of view by looking at Styling in the USA. Styling at the post-war economic heyday in the United States, emerges as the aesthetics of the consumer industry. The "clean" and modern aerodynamic surfaces were not only appealing but also represented the hygiene, cleanliness and comfort that all Americans aspired to. They were "aspirational". Material prosperity and abundance resulted in a common and identifiable language for all Americans, a unifying aesthetic (Hjelm, 2002). The sociological approach is therefore of particular interest to the topics to be addressed in this study, helping to understand to what extent cultural factors influence the aesthetic preferences of users. Baxter (1995) argues that social, cultural and business effects are fundamental in judging the form of products (and its attractiveness). He claims:

> *"Social factors, cultural factors and commercial or business factors all play a role and, as we shall see, they sometimes play such a strong role that they may override the more basic perceptual factors (…) Cultural influences on the perception of product style (and hence on form language) have a more long-term effect. The cultural context within which a society operates can have a pronounced effect on the values and beliefs held by individuals in that society. This, in turn causes certain aspects of product style to be valued and others to be disparaged. In Russia around the time of the revolution, for example, the lavish and luxurious lifestyle of the ruling classes became a focus for widespread public discontent (…) fueled by the political principles of Communism, all symbols of conspicuous consumption became politically incorrect. This led to strong utilitarian and industrial themes which emerged in product design throughout the Soviet era. This contrasts sharply with the trends in Western design during the 1980's when Reaganomics and Thatcherite monetarism gave rise to a hedonistic and materialistic culture in which conspicuous consumption thrived" (Baxter, 1995, pp 52)*

Another contemporary example would be the minimalistic design of APPLE products and retail spaces, with themselves an aspirational mode of relating to the customer who wants to buy an Apple product. Visual complexity which is many times the matter of product prestige, is on this case relegated to a simple, clean details highly complex technically object with a clean minimal appearance, reflecting probably the vision of its mentor Steve Jobs. In fact, contemporary mass manufacturing techniques can produce visual complexity at little extra cost (Baxter, 1995), but for Apple all the efforts go into not showing the great complexity of the product and using all means in order to "dress it" with a minimal package, extremely well designed and produced.

On another level, it is a much greater risk to try to pioneer a new style than it is to stick to existing styles (Baxter 1995) which means companies tend to imitate one another and "channel" the design, its Form Language, in the direction of the biggest sales brand. And this is what happens when all the first smart phones looked like Apple's own I-Phone. This is particularly true when a new product appears and as the new technology becomes mainstream different Form Languages tend to develop as new opportunities to appeal to different market segments emerge. The fact that different users will want different products is interesting in the way they interconnect it with a specific society:

> *"The work of Pierre Bourdieu (1979), in the context of the analysis and understanding of the mechanisms of social reproduction, is also a fundamental contribution (...) According to the author, the study of processes that allow societies to maintain their structure and institutions over time goes through, fundamentally, to understand how different social groups that are in unequal positions with respect to social power and control, develop strategies towards the maintenance (dominant classes) or alteration (classes dominated) of the places that occupy the social hierarchy ... Bourdieu integrates in his analysis of resources that each class has two fundamental concepts - that of social capital and that of cultural or symbolic capital, beyond economic capital. Since the three capitals are unequally distributed, social groups do not all have*

> *the same capacity ... Symbolic goods function as signs and are actively used by individuals to affirm prestige, social status, and belonging to specific social groups. That is, individuals actively use consumption to demarcate strategies of distinction and social identification." (Rosales, 2005, pp 301)*[9]

Users/consumers use products to distinctively show their personalities, social group and status as a way to communicate with others. From these dialogues between subject and object certain Form Languages tend to help characterize an Era as referred to by Deyan Sudjic (2008). This author considers that design and communication are manifestations of societies, their culture and technology:

> *"Design in all its manifestations is the DNA of an industrial society (…) It's the code that we need to explore if we are to stand a chance of understanding the nature of the modern world. It's a reflection of our economic systems. And it shows the imprint of the technology we have to work with. It's a kind of language, and it's a reflection of emotional and cultural values." (Sudjic, 2008, pp 49)*

In an ever more globalized society we now have access to all kinds of information and products independently of where they are manufactured or designed. Developing teams include designers, engineers, marketers from different nationalities and cultural backgrounds. Clotaire Rapaille (2007), anthropologist and marketer, believes that consumers from different countries still respond to a distinct cultural codes defined by individual or collective events in their societies. Rapaille studied American consumers concluding that the "code" for the Jeep model in the US was "horse." That is, the Jeep was associated with a horse, because it allows mobility / work on any type of terrain, close to the classic references of the American mid-west and the great open spaces. The author studied the same product in its relationship with the European peoples, and found that the differences were subtler. The same Jeep in Europe had liberating connotations because the American army expelled the Nazis at the end of World War II, so in France, in promoting the same brand, the model was associated with freedom. It will be important to conclude that these examples, of connotation of a brand in a particular culture, also serve the designers. In the use of semantic factors in the design of a product and in the choice of its Form Language, the codes present in each culture should be taken into account when designing for different brands:

> *"Symbolic communication is mattered through the concept of brand. Companies use branding increasingly as a strategic tool to enhance product differentiation. Brand, when understood in holistic terms, functions as the focal point of recognition. For a customer, products are differentiated through the brands they represent. Products embody meanings that are often even detached from the material dimension (…) The management of brand identity, as appearing through the messages the company wants to transmit to the market, involves an array of strategic decisions to be made prior to and during the design process." (Karjalainen 2004, pp 9)*

[9] this author's translation

In consumer society products represent the identity of companies. They are the tangible representation of the "corporate identity". Recognition of brands and products is merged into the perception of users / consumers (Montague, 1999). The aesthetic and emotional impacts of this approach result in complex association structures. As we have seen, people use objects to affirm their social position. But they also use them to communicate their own personality. When selecting a product, user will tend to express that the product is in accordance with his/her personal values, attitudes and vision of the world. This choice can either represent an individualistic personality or belong to a particular group (Karjalainen, 2004). Mozota explains:

> *Products are tools of communication that "put the consumer on stage" and help him exist as a social object (Solomon, 1983). The design form becomes a stimuli for behaviour. The social symbolism found in the form is the principal reason for buying the product. A design will be considered important if it projects an aspect of the consumer's self-image that is important to him. (Mozota, 2003, pp 90)*

In the search for more consumers, brands try to be connoted with certain types of personality / target audience. Through different product ranges, they try to attract the various consumer niches, using some common references. Certain anthropomorphic features, "baby faces", which we have already mentioned, can help explain the success of some models such as the VW Beetle, the Fiat 500 or the Mini. Baxter (1995) refers to the "determinants of style" for the brands as the different levels / strategies to promote attractive Form Languages. Certain types of forms such as "faces" and "natural shapes" can be appreciated by all users but, at the highest complexity level, style is determined by social, cultural and business factors (Baxter 1995).

> *"It is essential to recognize and define the physical product qualities that may have high semantic relevance in terms of specific brand associations. Different product qualities - such as dimensions, features, and characters - are often expressed by adjectival constructions. We may say that a product looks (or feels) "harmonic", "modern", "safe", and so forth. In effect, products are often given a character in a similar manner as human beings. This character refers to a coherent set of characteristics and attributes that apply to appearance and behaviour alike, cutting across different functions, situations and value systems. The character provides an end-user with support for anticipation, interpretation, and interaction. In the brand context, certain characteristics or attributes (for instance, supported by or embedded in specific design elements) signal to the user that while this product "seems" to be a product of that specific brand, it is anticipated to have that certain character." (Karjalainen, 2006, pp 21)*

As we have seen, mastery of the communication tools of a brand through Form Language is a competence that is expected from designers. Regardless of political or philosophical stance, communication tools must therefore be approached.

> *"A customer´s knowledge of a product is acquired through her perception of it. A customer´s behaviour, then, is determined by how she perceives the products and services around her (…)*

The visual differentiation introduced by design is perceived by the final consumer. The product shape influences the consumer's behaviour." (Mozota, 2003, pp 83)

We can therefore conclude that part of the designer's task today, when designing for a brand, is to consciously control the codification and materialization of meanings in the products, so that users / consumers can interpret them (as functional, responsive, user friendly) but also as aesthetically and cultural relevant to the users as they will incorporate them as a way to communicate their social status and personality to other users. By managing some consistently a selected Form Language, brand-specific references are created that can be visually recognizable (Warell, 2001). It remains to consider the cultural, ethical, political and sustainability implications of this approach, in an attempt to contribute to a more active and responsible role of the designer in society.

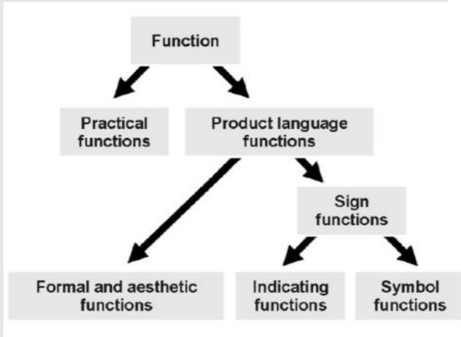
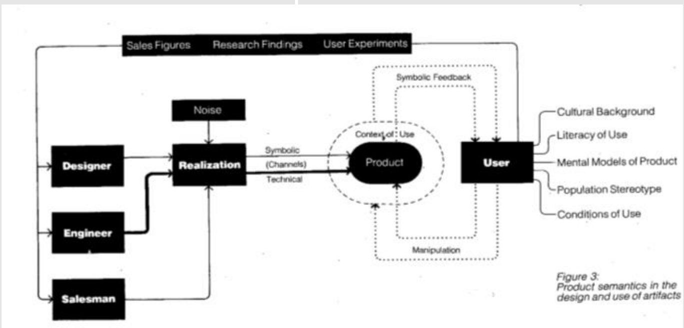
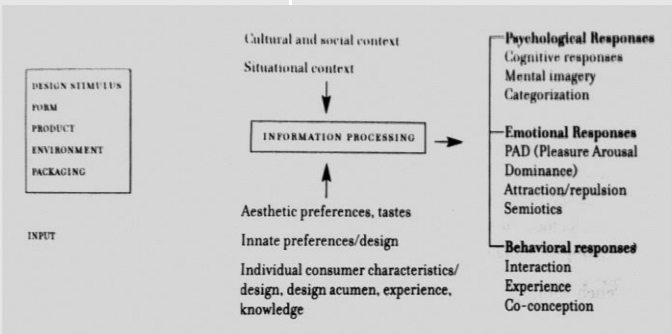
Synthesis of the chapter

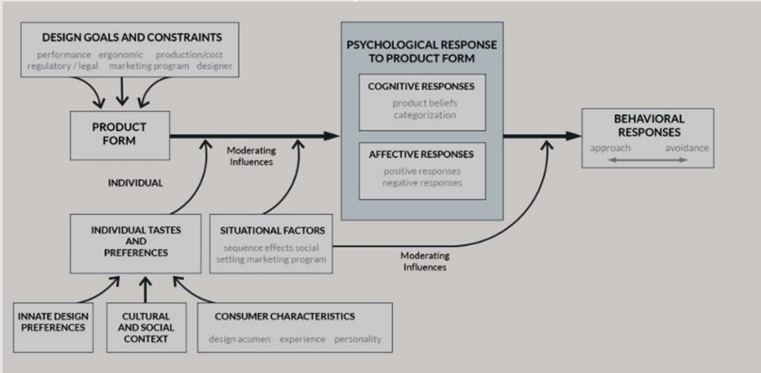
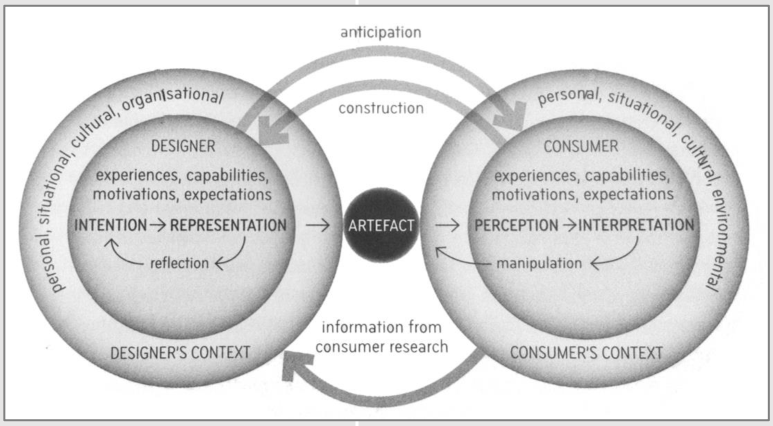
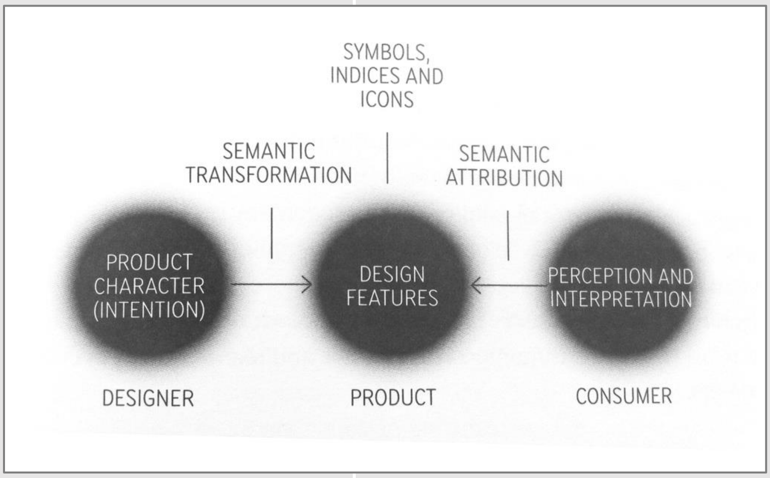
The aim of this chapter was to establish a theoretical framework around the investigation vector "Form Semantics" defined as the review of texts with focus on the meaning of artifacts, on the semantic transformation in design, that is the attributed of specific signs in objects and their interpretation by users in order to study the specific case of Almadesign form semantics. The main objective of this section is to establish a theoretical framework around the topic of "Form Semantics" analysing the following topics:

- Theory of product language
- Semiotics
- Communication models
- Social and cultural associations

The part was fully based on literature review. The main findings of this chapter would be the description of the most important princples regarding the development and decoding of a specific Form Semantics in a design context. The different elements studied provided a framework with which the researcher was abele to analyse specific studio Case Study projects. In order to analyse the information in the most simple a visual way possible, the following chart sums up the main findings.

Table 4 - Summary of Literature Review on Form Semantics

LITERATURE REVIEW: FORM SEMANTICS			
Categories	**Elements**	**Definitions**	**Example**
Theory of product language	Function is divided into Practical Functions and Product Language Functions	Product Language functions are divided into Formal and aesthetic functions and Sign Functions. The latter are divided into Indicating functions and Symbol functions	
Semiotics	Types of Signs Denotation Connotation	Icons, Indexes, Symbols Level 1: primary denotation: common shared knowledge; Level 2: secondary denotation: objective, but only some people know it; Level 3: primary connotation: negative or positive, different for everyone; Level 4: secondary connotation: very specific knowledge or thought of knowledge about the object;	 ICON INDEX SYMBOL
Communication models	Product Semantics		
	Consumer behaviour		

<table>
<tr><td></td><td>Psychological response to product form</td><td>
</td></tr>
<tr><td></td><td>Communication-based model of design</td><td>
</td></tr>
<tr><td></td><td>Meaning creation</td><td>
</td></tr>
<tr><td>Social and cultural associations</td><td colspan="2">Meaning are co-determined by the users
Cultural context influences the perception of product style and form language
Existing styles are less risky
MAYA: most advanced yet acceptable
Product are tools of communication that put the consumer on stag
Social symbolism found in the product “form” is a reason for buying a product if it projects an aspect of the consumer’s self-image that is important to him</td></tr>
</table>

(source: researcher, 2017)

PART III – EXPERIMENTAL STUDIES

PART III: EXPERIMENTAL STUDIES

Overview

Part III - Experimental Studies was developed during a two year period and includes three Experimental studies developed with Students at FA-ULISBOA in Lisbon (Experimental Study #1), with designers at Almadesign Studio (Experimental Study #2) and with Almadesign studio clients and partners (Experimental Study #3). The empirical studies were grounded in the literature study and provided valuable information for the development of the investigation aiming at a deeper analysis of the theoretical framework but also reframing the investigation questions and methodologies. Taking into consideration the three research vectors – Context, Syntax and Semantics – the Studies used different approaches and, whenever possible, the same studio baseline projects as Case Studies. This Part is organized in 3 chapters, each referring to a specific Experimental Study.

Structure of Part III

This part is structured in the following way:

- Chapter 1 presents the work developed for Experimental Study #1: "Reverse inspiration: educational approach on the analysis of Form Language in design studios", including the Objectives, Methodology, Results, Discussion and Conclusions;
- Chapter 2 presents the work developed for Experimental Study #2: "Box of favorite things" including the same topics as Chapter 1;
- Chapter 3 presents the work developed for Experimental Study #3: "Almadesign Visual Language" including the same topics as Chapter 1 and 2;
- The chapter synthesis concludes this part highlighting how the work developed contributes to the overall objective of the investigation.

1 Experimental study #1: Reverse inspiration

1.1 *Introduction*

Experimental study #1 was named “Reverse inspiration: educational approach on the analysis of form language in design studios”. The title is directly connected with the technical term “reverse engineering”, a process by which an object / product is 3D scanned into a digital format. By analogy, the aim of this exercise was to use an educational approach – in class with Design Master students - to grasp a first impression on the Form language of design studios by trying to “reverse” the inspiration process for each project, in an exercise of “future” professional designers. Through selected projects, students analysed Form Languages of selected design studios and created inspirational/reference moodboards on the basis of the analysis. In addition to educational contribution to the field of design, these exercises generated insightful qualitative data concerning the Form Language of the studios and particularly Almadesign.

1.2 *Objectives*

The following objectives were set for Experimental study #1:

- To analyze the Form Language of several design studios and try to use a “reverse inspiration” process trying to deconstruct the process of inspiration, references which led to the project’s Form Language;
- To compare Almadesign Studio Form Language with other competitor studios, trying to discover possible common elements, differences, constants, etc.
- To reframe the investigation question according to the results of the study.

Being the first empirical study, it was fundamental for the investigation to gather information about how design students perceive the Form Language from different studios, and specifically if they would found Almadesign projects had specific characteristics which were unique and could define a specific Form Language. The initial hypothesis was: “it is possible to define a specific Form Language in Almadesign studio”. The hypothesis was to be tested by this first Experimental study and reframed if needed.

1.3 *Methodology*

1.3.1 Dates, participants and sample size

Experimental study #1 was developed in the period from the 1st October 2015 to 15th February 2016. During this period, several tasks were tackled in the investigation such as Planning Activities, Literature Review and Empirical Investigation activities. These were developed iteratively, meaning that some of them were not exactly planned from the beginning, but were found to be important for the investigation. As the process moved forward, some of the more explorative activities took the “lead”, other times a more theoretical approach was preferred. The Experimental study was prepared by the research team and implemented during the 1st Semester of the Master in Design classes at FA-ULISBOA. This was a qualitative study with design students and the objective was to gather data on the Form Language of design projects developed by Almadesign studio and competitor studios. Data to be collected included keywords and moodboards which were developed by the students. The study was developed with 15 Master Design students during two 4,5h sessions in November 2015.

1.3.2 Evaluation approach

The following chart summarizes the evaluation approach developed by the researcher:

- Type of study; What needs to be measured; Data collection method; Access issues / Tools; Timeline; What was done

Table 5 - Experimental Study #1: Evaluation approach

EXPERIMENTAL STUDY #1 - "REVERSE INSPIRATION"					
Type of study	**What needs to be measured**	**Data to be collected and collection method**	**Access issues / Tools**	**Timeline / Venue**	**What was done**
Qualitative study with design students conducted in Master Design classes	Semantic references related to design projects (Almadesign studio and competitors); Inspirational references related to design projects (Almadesign studio and competitors)	Keywords; Discussion comments; Moodboards; Projection of images from selected projects; list of keywords per project per student; group discussion; organization into 5 work groups of 3 students each, generation of 5 Moodboards per group	Researcher was a teacher of the Master Design Course; students were attending a course in Product Design and Development; Work was developed in 2 sessions of 4,5h each, during 1 week in November 2015; work was developed in class, with part of the image research for the Moodboards developed in between the 2 sessions	Faculty of Architecture, Urbanism and Design FAUL, Lisbon; October 2015;	Experimental study was prepared via a selection of images from different projects of different studios; the researcher conducted the Experimental study in 2 sessions; 1st session included the projection of images and keyword referencing; the second session included the researcher for images to assemble Moodboards for each group of selected projects; Data was organized; Word count for quantitative analysis; Images selection for qualitative analysis; Preliminary conclusions were collected

(Source: researcher, 2017)

1.3.3 Procedure

Two sessions were prepared and implemented in classes at the Product Design Master at FAUL in November 2015. The name of the study “Reverse inspiration: educational approach on the analysis of form language in design studios” was mentioned was well as its integration in the PhD research on the "Form Language of Almadesign". In the first session, with 15 Master students, the researcher projected images from 15 selected Design projects in three categories:

- Aircraft Interiors (Airline);
- Aircraft Interiors (Private Jet);
- Railway Interiors (Urban / Intercity trains).

In each category, there were 5 projects: 1 Almadesign studio project and 4 projects from competitor design studios. In total, this meant there were 15 projects to be analyzed by the students. Each group of categories included 1 project from Almadesign Studio, and 4 other studios with similar referential themes and projects (airline, private jet, and railway). They were selected as these studios are considered direct competitors of the studio, offering the same type of services and addressing similar types of clients, design processes and competencies such as: market research, concept design, design development, 3D visualization, prototype building, branding. These studios were selected albeit their different sizes, revenues, etcetera, but focused on the typology transport projects they develop.

The selected projects were chosen by the researcher after a review in industry magazines such as Railway Interiors, Aircraft Interiors International and Business Jet Interiors and also by consulting Almadesign own archive of benchmarking projects. The projects were considered “benchmark” examples, able to provide a baseline for comparison to Almadesign’s own projects. They featured similar typologies, scale, functional needs, etcetera, enabling a focus on the Form Language elements developed. The following Almadesign projects were selected for the Study (Figure 89):

Figure 89 : Study #1: Project newFACE; Project LIFE; Project INTRAIN source

Competitors included design studios Priestman Goode, Tangerine, Teague, JPA Design, Designworks USA, Mercedes Design. Also included are internal design departments of OEMs such as Embraer and Bombardier. These are all design studios working in the field of Transport Design with visibility in the market. The projects were organized in three typologies and were presented to the students as such: Airline cabin projects; Private Jet projects; Railway interior projects. The following images were used during the sessions with students (Figure 90-92):

- Airline projects:

Figure 90 : Teague, Almadesign (AD), JPA, Priestman Goode, Tangerine (source: researcher, 2015)

- Private Jet projects:

Figure 91 : AD, Mercedes, PriestmanGoode, Embraer Design, Bombardier Design (source: researcher, 2015)

- Railway projects:

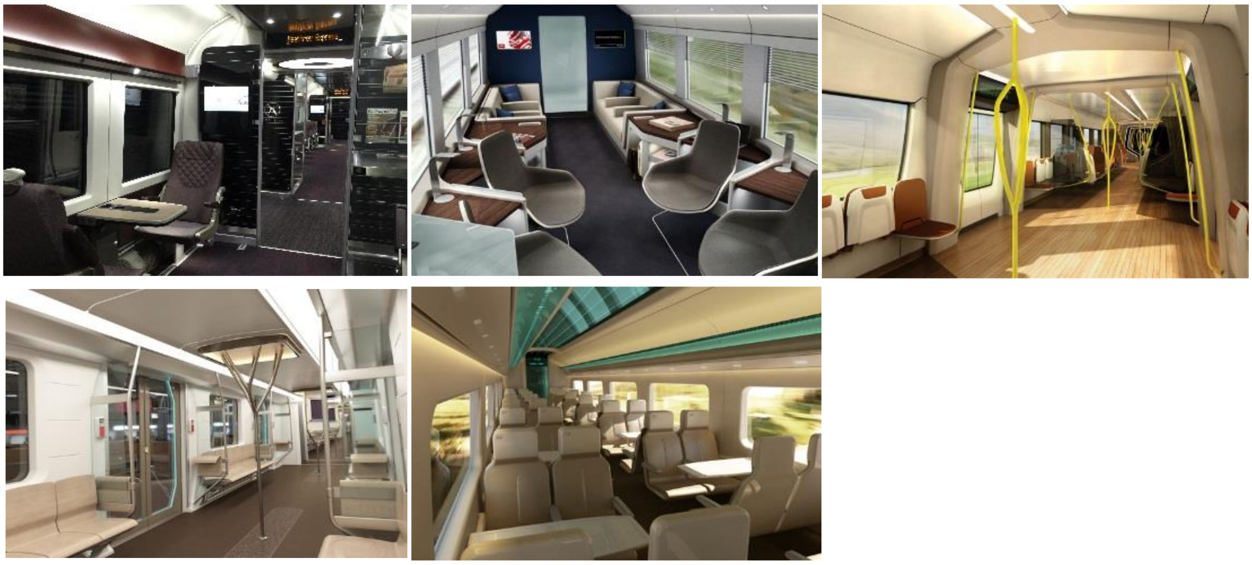


Figure 92 : Tangerine, Priestman Goode, AD, Designworks USA, JPA (source: researcher, 2015)

Session 1 started with the projection of images of 5 projects in the first category, Airline Cabin Interiors. Students were asked to observe the pictures for about 5 minutes each, and write a list of keywords which would describe their impressions on the Form Language of the projects. Keywords should reflect their personal analysis of the projects, and the following guidelines were given to the students:

- Keywords should:
    - reflect your personal opinion about the design;
    - reflect evoked memories and emotions;
    - reference Form Language characteristics (shape, color, materials, other…).

The session had a duration of about 1,5 hours, followed by a 30-min discussion between students and the researcher. Towards the end of the discussion, students organized 5 groups of 3 students to tackle the second part of the exercise which consisted in gathering imagery which referenced each of the category projects (5 for each group) to develop a Moodboard for each project. Images should address the following themes:

- Product Design;
- Architecture;
- Fashion Design;
- Movies;
- Comics;

- Nature.

Based on these images, students were asked to design specific Moodboards for each project, and associate keywords which would describe the product in terms of its Form Language. The students were briefed in how to design a Moodboard and had 3 days in between sessions to gather the images. During Session 2, the Moodboards were completed with the supervision of the researcher. The brief about the Moodboards included a definition of what are the objectives of this methodology and how it is applied in the professional design studios, as explained by Baxter (2004):

> *"(…) a "moodboard" tries to identify a single expression of values for the product, which will appeal to customers with the identified lifestyles. The mood of the product is the sentiment, feeling or emotion which the product engenders when first seen (…) A mood board has an important communication role to play. It gives all members of the design team a common styling objective and allows that objective to be communicated beyond the design team to management and even clients or customers (…) products can be given very different and quite distinctive styles by following the structured use of lifestyle, mood and visual theme boards. These styles are carefully and deliberately derived from an understanding of markets needs and they are focused on specific interpretations of customer value" (Baxter, 2004, pp 224-225)*

The "Moodboards" expressed the references the students identified in the projects, after some reflection and group discussion. This provided a visual analysis of the Form Languages used in different projects, including Almadesign and its competitors. The final outcome was a list of about 1250 words and 25 "Moodboards" representative of the selected projects (full spreadsheet with this information is accessible in the Annexes).

1.4 ***Data Collection***

During the two sessions the following data was gathered:

- 1250 Keywords;
- 25 Moodboards (1 per each project showcased), 5 per group of 5 students.

The keyword list was originally in Portuguese. Words were then translated by the researcher in order to present the results in English. The keyword list was compiled in one single spread sheet (see Annexes), with each row serving as the "list of words" per student, and each column with the 15 projects (divided in 3 groups of 5 projects). The Moodboards were gathered in a single document in which the initial project was represented together with the results developed. The following figures depict a part of the spreadsheet developed (Figure 93) as well as an example of 1 of the 25 Moodboards developed by the students (Figure 94):

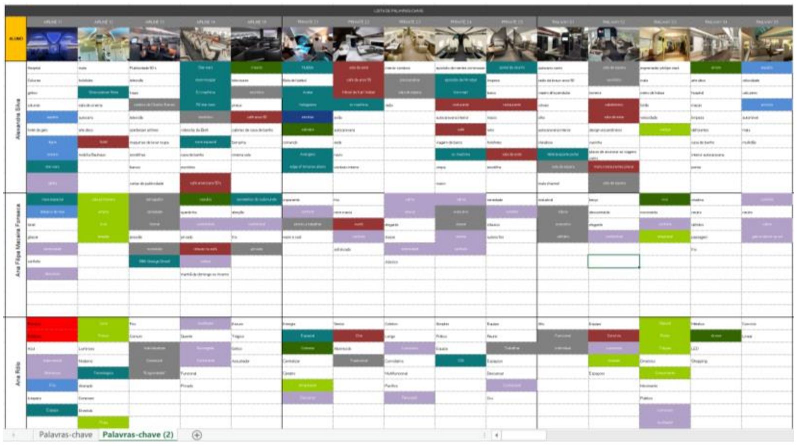


Figure 93 : Experimental study #1 – Data gathering spreadsheet (source: researcher, 2015)

Figure 94 : Experimental study #1 – Students' Moodboard on newFACE project (source: researcher, 2015)

The keyword list size regarding the different projects was not previously defined by the researcher. The students were free to write down as much words as they wanted to. The keyword list was the basis of the Moodboard development, for which the students had more time to refelct upon, since there were two days in between the sessions. Because of the very big amount of data gathered and the great differentes in the descriptive words, the researcher devise the folowing strategy for analysis:

Table 6 - Experimental Study #1: Data collection and analysis

DATA COLLECTION AND ANALYSIS			
Data gathered	**Quantitative analysis #1**	**Quantitative analysis #2**	**Qualitative analysis #3**
1250 Keywords 25 Moodboards (images and keywords)	Keywords for Almadesign Studio projects grouped by frequency; visualization of results via tag crowd software tool;	Keywords grouped by categories; percentage of each category compared between Almadesign studio projects and competitor projects;	Moodboards were gathered in a single document; qualitative analysis and comparison between Almadesign projects and competitors' projects;

(source: researcher, 2017)

- Data analysis #1: using word count and word cloud software, researcher analysed word frewuency in the list of keywords for each of Almadesign studio project. This allows for a visual comparision and analysis of the word frequency regarding Almadesign studio's form language;
- Data analysis #2: grouping keywords into specific categories, allowed the researcher to define specific thematic groups for each project analysed. This enables the comparison of specifc thematic groups between Almadesign studio proejcts and competitors projects;
- Data analysis #3: grouping and analysing Moodboards developed (images and words), some conclusions about form language and visual references were defined by the resercher.

1.5 ***Results #1***

A preliminary analysis to the results of the exercise was developed by the researcher. Three types of analysis were made as mentioned. The first was a quantitative / qualitative analysis of the keywords defined by the students, directly related to the 3 Almadesign projects. For each Almadesign project a Wordcloud image was developed, based on the listing of keywords (translated from Portuguese to English by the author). The results can be visualized in the following figures, for each of the 3 Almadesign projects analysed: newFACE project, LIFE project and inTRAIN project.

1.5.1 Project newFACE

Below we can see one of the images used during the Experimental study #1 exercise with students. Besides it a wordcloud displays the word frequency in a graphical manner, Figure 95. A brief analysis was also developed on which are the most common words and there are grouped into categories.

Figure 95 : Study #1 – Project newFACE and Wordcloud (source: researcher, 2017, www.tagcrowd.com)

From the preliminary analysis of the keywords selected by students for Almadesign newFACE project, results are the following: most used words are NATURE and CONFORTABLE (5), BRIGHT and AIRY (4), SCI-FI (3) and then words like CLEAN, COLOR, ECOLOGICAL, FOREST, FRESH, LIGHTNESS, SKY, SPACE, STARWAS, TUNEL (2). Other words were used just once, which can also relate to some of the main themes, such as SUSTAINABLE, ORGANIC, OPENAIR, PARK, GROWTH, COUNTRYSIDE (1), etc. In trying to organize the different words selected in specific categories, we decided to use 3 Categories which can include groups of words. These categories are based on a qualitative selection and interpretation by the researcher, and can some words can probably fit different categories:

- CONFORT: clean; airy, lightness, bright, fresh;
- NATURE: forest, sky, colour, nature;
- SCI-FI: starwars, space, tunnel, sci-fi.

As the study was supported only by images (and not a real project) some (mis) interpretations are bound to have happened. Nevertheless we can try to interpret how each word fits each item in the project. For instance, the category COMFORT includes the words CLEAN, AIRY, LIGHTNESS, BRIGHT possibly because of the layout of the interior, where the non-existence of upper bins, allows for greater space on top, as only the lighting and the air ducts are included in the central element. On the other hand, the way the color lights the two aisles on each side of the central element and how it reflects on the ceiling, makes for a bright comfortable look and feel.

As for the NATURE references, as the FOREST, SKY, COLOUR can possibly be related to the fact that CMF privilege the green detailing in the seats, with soft bright colors, with the ceiling projected with colors as if it were a real sky view, and the center element arching towards the lateral walls in soft gentle curves also helps to achieve this effect.

The SCI-FI effect was specifically referenced by students who compared the colored lighting strips to “star wars lightsabers and lasers”. The effect of the light on the ceiling like if the center element is floating, the repetition of elements (window panels and seats), and the very clean shapes of the seats with specific detailing (the circular element on the headrest looks like a technological gadget such as a sensor or a camera, much like an element form a star wars robot) all contribute to a “spaceship” approach which probably accounts for the SCI-FI references.

1.5.2 Project LIFE

Below we can see one of the images used during the Experimental study#1 exercise with students. Besides it a wordcloud displays the word frequency in a graphical manner, Figure 96.

Figure 96 : Study #1 – Project LIFE and Wordcloud (source: researcher, 2017, www.tagcrowd.com)

From the preliminary analysis of the keywords selected by students for Almadesign LIFE project, results are the following: most used words are FUTURISTIC, SCI-FI and HONEYCOMB (5), CONFORTABLE (3) and then words like HIGH-TECH, HOLOGRAM, DAWN, NATURE, ORGANIC, PLANET, POWER, SPACESHIP, TECHNOLOGY, WORKSPACE (2). Other words were used just once, which can also relate to some of the main themes, such as BIONIC, BUBBLE, MINORITY REPORT, STARS, SPACE, TRUSS, etcetera. In trying to organize the different words selected in specific categories, we decided to use a small number of Categories which can include groups of words. Again, these categories are based on a qualitative selection and interpretation by the researcher, and some words can probably fit different categories:

- SCI-FI: futuristic, planet, high-tech, hologram, spaceship, sci-fi
- NATURE: honeycomb, organic, dawn, nature
- CONFORT: comfortable
- HOME/WORK: workspace, power

In trying to make an attempt at interpreting how each word fits each item in the project, most categories seem to be constant and coherent except maybe from a few words. For instance, the category COMFORT includes the word POWER, which can be probably be related to the knowledge of this project being a Private Jet, with seats as COMFORTABLE thrones for the rich and powerful, or even a WORKSPACE when we include the immersive sphere with a seat inside.

For the category NATURE we can argue that the references to the HONEYCOMB are directed at the truncated polyhedron which makes up the immersive sphere with is pentagons and hexagons, adding the shape of the windows and seats, with soft curves and hexagon shapes objects which could relate to the word ORGANIC. Both words build up a NATURE scene which can be further underlined by the DAWN sun at the background of the image.

For the category SCI-FI, the HOLOGRAM like touchscreens with light projections seem to be the most prominent objects to reflect HIGH-TECH, TECHNOLOGY, which together with the sphere with a lit up seat inside, triangular softly shaped windows and floating seats lit up from below, all make for a SCI-FI or FUTURISTIC appearance of a SPACESHIP. Finally, the ceiling lit up like a star constellation probably gives rise to the appearance of the word PLANET.

1.5.3 Project inTRAIN

Below we can see one of the images used during the Experimental study#1 exercise with students. Besides it a wordcloud displays the word frequency in a graphical manner, Figure 97. Just as in the previous projects, a brief analysis was also developed on which are the most common words and there are grouped into categories.

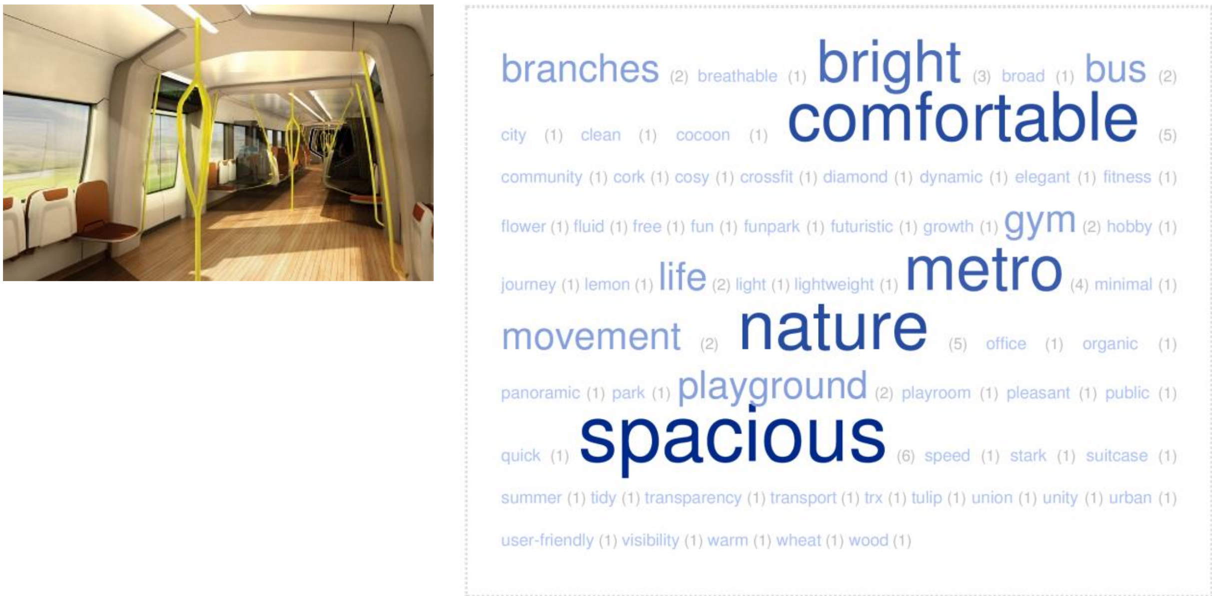


Figure 97 : Study #1 – Project inTRAIN and Wordcloud (source: researcher, 2017, www.tagcrowd.com)

From the preliminary analysis of the keywords selected by students for Almadesign inTRAIN project, results are the following: most used words are SPACIOUS (6), NATURE and COMFORTABLE (5), METRO (4) and BRIGHT (3) and then BRANCHES, BUS, GYM, LIFE, MOVEMENT, PLAYGROUND (2). Other words were used just once, which can also relate to some of the main themes, such as PLAYROOM, ORGANIC, COSY, BREATHABLE, CLEAN, WARM, WOOD, etc. In trying to organize the different words selected in specific categories, we have used a small number of Categories which can include groups of words. Again, these categories are based on a qualitative selection and interpretation by the researcher, and can some words can probably fit different categories:

- CONFORT: bright, spacious, playground, comfortable, warm
- NATURE: branches, life, movement, organic, breathable
- OTHER: bus, metro, gym, clean

As mentioned before, the study was supported only by images (and not a real project) which can lead to a lot of (mis) interpretations, which are bound to have happened. Nevertheless we can again make an attempt at interpreting how each word fits each item in the project. For instance, the category COMFORTABLE we decided to include words like BRIGHT, SPACIOUS, WARM, and even PLAYGROUND which is accounted for the large space in the entrance area on the inTRAIN project. This was a decision which has to do with being able to change form the flip-up seats not being in use to every flip-up being used in case of a peek time with more passengers. In such a way, by keeping the entrance open and uncluttered, passengers are bound to enter the carriage and take a seat. It is this layout, together with the use of natural light and materials (such as the wood flooring) which possible accounts for this keyword scoring.

When it comes to the word NATURE, the BRANCHES and probably referring to the central handrail which also serves as a central point for the distribution of passenger around it. Also, the ceiling central element which branches form the side into the entrance pillars gives another anthropomorphic cue which is probably attached to the MOVEMENT and BRANCHES reference. On the other hand, references to a CLEAN space and to the natural functionality of such a transport system are also evident (BUS, METRO, etc).

To conclude Experimental study#1 analysis, two further methodologies were used. The keywords were further organized into specific categories which could be used to compare the different projects and its relative scores (using percentages). And finally, a qualitative analysis of the Moodboards developed was also used in order to have a different approach towards Almadesign projects.

1.6 ***Results #2***

Data analysis #2 intended to check for constants and/or changing elements between Almadesign studio projects and competitors' projects, in order to establish possible patterns. The grouping of each word in a specific category was devised, in order to compare categories of all different project. Comparing to the word frequency this would enable the researcher to find other patterns, hidden in the huge diversity of words chosen by the students, but which can be organized to specific categories. The following categories were defined:

- SCI-FI: included keywords that directly mention Sci-fi movies or Games and futuristic scenarios (i.e. space ship, storm trooper, star wars, futuristic, etc)
- NATURE: includes words that directly mention nature, natural settings, biomimicry processes (i.e. nature, park, open air, forest, flower, life, cocoon, beehive, water, sky, etcetera)
- HOME / WORK (or HOMEWORK): includes words that make a reference to home environments or work facilities (e.g. living room, work, meetings, work, food, etcetera)
- COMFORT: includes words that directly reference comfort settings (relaxing spaces, etcetera (i.e. comfort, relaxing, etcetera)

These 4 categories account for about 50% to 75% of the words chosen by the students (from a total of 1250 words). The words not mentioned were not considered relevant to this study (for instance words describing specific objects for instance, as “neutral” or “colors”) or were included in long expressions from which it was difficult to understand one specific meaning. The different words were organized in charts with the specific categories and its percentage according to each project. The following pages include the analysis of the results for each category and for each of the 15 projects, with specific focus on Almadesign's projects.

1.6.1 Project newFACE

Below we can see the 5 projects presented during Experimental study #1 exercise with students (Table 7). The 5 projects present 5 airline interior projects, some of them already in production, some as concepts. The results of the category grouping can be seen in the chart below, where the keywords referring to each category: SCI-FI, NATURE, COMFORT and HOME-WORK are distributed in percentages for each of the projects.

Table 7 - Experimental Study #1: "keyword" percentage by group for "Airline" projects

					
SCI-FI	23%	19%	5%	16%	11%
NATURE	42%	71%	5%	22%	9%
COMFORT	35%	8%	11%	24%	6%
HOMEWORK	0%	2%	78%	38%	74%
TOTAL	100%	100%	100%	100%	100%

(source: researcher, 2016)

If we analyze each category line, for the SCI-FI category Almadesign project has a 19% of keyword references, only surpassed by the first project (Boeing 787 interior concept) with 23%. Arguably one of the most important concepts of the beginning on the century, the 787 interiors came to be the most prized aircraft interior cabin, with its concept being adapted to the whole Boeing range as the "Sky Interior" cabins (now present in 787 but also in the 747 and 737 ranges). This project, featuring a stunning entrance with large soft curved arches and mood light colors creates a feeling of a flying "spaceship". Almadesign's project newFACE includes some specific features which can be considered "futuristic" and appeal to the sci-fi references designers have. For instance, there are no upper bins to store luggage (it is done via a flip-up seat pan) and hence the ceiling is free from any element other than lighting and air ducts. This creates a very luminous space, which with the colored LED in tones of green and blue and the strips of light in the center element - with soft arches - bring a Sci-Fi element to the composition. One of the students pointed out specifically that the transversal LEDs on the center element resembled lasers and lightsabers in Star Wars movies. Arguably, even the seating, with its round element, was possibly identified with some technological element (such as a sensor or a webcam) much like we would find in a robot from a sci-fi movie. The "dovetail" JPA cabin design scored 16% possibly due to the unconventional configuration of the aircraft seats (dovetail layout) with a "spinal layout". The "capsule" like repetitive modules which involve the passenger were also referred to as SCI-FI referring.

On the second line, for the NATURE category, Almadesign scored higher than all the other projects, a 71% of keywords, with the closest being the 787 concept interior (42%). The JPA "dovetail" concept scored 22%. These concepts come in line with the most referenced keywords for this project, which included nature related words as forest, sky, fresh, airy, etc, focusing on the open-air feeling of the high ceiling, airy and colorful. As already mentioned, the concept features an airy architecture with lots of space on the ceiling, colored lighting projecting as if you could look directly at the sky above you, a center element in which we can find anthropomorphic references, all of which contribute to the “nature” look referred to by students. The green color used in the seating, a clean overall look and the use of natural wood on the flooring possibly also contribute to this result. We can also see that students found references to nature concepts in the 787 interiors, possibly due to the fact the entrance (as a “cathedral effect”, opening up from a narrow passage which is the aircraft door) with its soft shaped arches and blueish underwater colors also have a huge impact on our perception. The use of colored light in now becoming a standard feature in long-haul flights with the possibility to program it to change during the different sequences of the flight (e.g. take-off, sleep, meal, etc).

Looking at the third line, the COMFORT category (8%) was not visually much perceived or transmitted the Form Language of newFACE project. Strangely enough, this was one of the most repeated words for this concept, but not with much other references to it which would fit the comfort category. This is quite interesting to compare with the word cloud tool as that one would lead us to conclude that comfort was a fundamental concept but if we include the categorization, it is actually not that important when compared to the Sci-fi and specially the Nature references. Therefore it was decided to look at the same issue from different perspectives. The highest score here was again the Boeing Concept, possibly due to the airy space, considered relaxing, pleasing and good for “sleeping”, cozy, calm “underwater” light and color combination. The “dovetail” JPA design concept follows (24%) possible since each passenger has its own niche, private space, in soft colors (light beige and orange) which provide a comfortable, individual, “organic cabin” space.

The fourth and last category, which combines the concept of HOME and WORK environments, it was not at all considered important for the newFACE project by the students. The EJETS 2 cabin concept by PriestmanGoode scored very high (78%) possibly because the individual 1st Class seats are reminiscent of classic luxury chairs with leather finishing such as the Eames’ Lounge Chair, a classic reference to design students, and the pillows give the extra details for communicating comfort. Tangerine’s Airbus A330 business class was highly correlated to work environments and office like spaces as well as movie theatres possibly due to the repetition of elements in a dark colored setting. Individual, office style and male references were predominant for this project. Finally, the “dovetail” concept by JPA was also considered in this category (38%) which is also possible since the individual niches soft colors and pillows have a home-like (more than office) connection, with cocoon like lounging spaces.

1.6.2 Project LIFE

Below we can see the 5 projects presented during Experimental study #1 exercise with students (Table 8). The 5 projects present 5 private jet interior projects, some of them already in production, some as concepts. The results of the category grouping can be seen in the chart below, where the keywords referring to each category: SCI-FI, NATURE, COMFORT and HOME-WORK are distributed in percentages for each of the projects.

Table 8 - Experimental Study #1:“keyword” percentage by group for “Private Jet” projects

					
SCI-FI	46%	11%	0%	26%	2%
NATURE	32%	9%	7%	8%	7%
COMFORT	13%	20%	36%	26%	32%
HOMEWORK	9%	59%	57%	41%	59%
TOTAL	100%	100%	100%	100%	100%

(source: researcher, 2016)

If we analyses each category line, for the SCI-FI category Almadesign project has a 46% of keyword references, with a 26% Embraer design project featured afterwards and Mercedes Design concept with 2%. Almadesign’s project LIFE was arguably the most important project the studio has developed to date, as it was awarded and published in hundreds of industry publications worldwide. As mentioned before, this project is connected to different aspects from the high-end private jet interior, to a prototype to Experimental study natural materials (leather and cork are clearly visible). But for the category SCI-FI, as mentioned, a lot of elements come into place such as the hologram like touchscreens with light projections, which also reflect technology, the floating seats lit form underneath, the colored light scheme, the innovative triangular windows, the sky lighting concept with fiber optics, and, of course, the central piece, which is the immersive sphere which by its shape, structure and lit up truncated polyhedron pattern. The sphere shape is a constant in sci-fi movies and futuristic architecture and design (e.g. 2001 astronaut modules, Buckminster Fuller’s futuristic dome structures, etc). Its inspiration also comes form a lot of different references, one of which the movie Avatar, which combines Nature and Technology in a specific way, using of course shapes, colors, and form to do it. The project was considered by design peers as something of a “spaceship” in the sky. Embraer project, by its use of CMF, specifically the color white with black enabling the use of high-contrast parts which combined have the high-tech, luxury and futuristic interior.

On the second line, for the NATURE category, Almadesign scored higher than all the other projects, a 32% of keywords, with the closest being the Mercedes concept interior (9%). This category encompasses aspects as the honeycomb shaped sphere, with its pentagons and hexagons, the soft shape of the seat and triangular slightly curved shaped windows, which are also underlined by the background and lighting of the scene. The other concepts were fairly related to nature elements, and are so much more associated with artificial elements, materials and technology.

It is in the CONFORT category that Almadesign LIFE project scores less when compared with the other projects. Contrary to the Sci-fi category, PriestmanGoode's interior for the Embraer Lineage 1000 is the highest scoring considering comfort. Its "classical" appeal, with large seats with big comfortable cushions in leather and bright home like colors make it the most comfortable project in terms of visual perception. This overrides Almadesign project, with its "flatter" seating and less cushioning. Perhaps a futuristic look is never deemed as so comfortable as a home like environment. Bombardier also scores high on the comfort perception (32%) probably also connected to the large seats with cushions and color material and finish form the home environment.

In the Home / Work category these 2 projects, Embraer's Lineage (57%), Bombardier (59%) as well as the Mercedes concept (59%) score the highest. The Mercedes concept in itself is referred to as a Home like "James Bond" environment by students. The fact that all 3 projects have direct references to home-like environments such as tables and tableware, sofas / couches, fabric covers and pillows, and even coffee tables. These references are very strong and contribute to a homelike feeling, with places where you have your meals and rest. The use of specific CMF schemes with bright, light colors and brown / beige fabrics or wood finishes also help to enhance this feeling. The classical style of the seats can also contribute, but in this case Mercedes has a different approach with a form language which gets closer to the LIFE project design but for which the pillows give an extra comfort look and feel, and with a form language which is more innovative in the connection between ceiling parts, side walls and flooring, all visually united under one curved shape with specific color, materials and finishes.

1.6.3 Project inTRAIN

Below we can see the 5 projects presented during Study#1 exercise with students. The 5 projects present 5 railway interior projects, some of them already in production, some as concepts. The results of the category grouping can be seen in the chart below, where the keywords referring to each category: SCI-FI, NATURE, COMFORT and HOME-WORK are distributed in percentages for each of the projects.

Table 9 - Experimental Study #1:"keyword" percentage by group for "Railway" projects

					
SCI-FI	13%	0%	6%	4%	0%
NATURE	0%	4%	64%	52%	45%
COMFORT	13%	13%	22%	0%	26%
HOMEWORK	74%	83%	8%	44%	29%
TOTAL	100%	100%	100%	100%	100%

(source: researcher, 2016)

If we analyses each category line, for the SCI-FI category Almadesign project has only 6% of keyword references, and it's clearly surpassed by the first project Tangerine's Heathrow Express railway interior (13%). This train interior, which services a fast connection between London airport Heathrow and the city center is a modernization of a previous train in 2 classes for fast access for essentially business travelers. One can argue that the dark colors and glass finishes with embedded screens help to determine a somewhat sci-fi interpretation of the project.

In the NATURE category, it is interesting to see that Almadesign's project is in first place, followed closely by DesignworksUSA Subway project. On both projects we can see a very strong element, which is the handlebar in the middle of the carriage that carries a nature / tree branches analogic form language. In case of the inTRAIN project this is further underlined by the ceiling shape which branches down into the side entrance pillars. In both cases, the use of wood finishes (for the flooring in inTRAIN and for the seats in DesignworksUSA project) and warm tones also helps explain the nature scoring.

In the COMFORT category, it is inTRAIN project which gets the second higher score (22%). The first, JPA train interior concept is referred to as being more comfortable. This can be directly related to seats looking wider and more comfortable. Nevertheless, inTRAIN project gets to be seen as the second more comfortable for its environment, as we cannot see a lot of seating places. So, the combination of form, colors and finishes with a nature theme helps define a comfortable, likeable environment. Other projects do not score that well in terms of percentage of words related to comfort, probably because they have a much higher score in the final category home-work.

In category Home / Work, Tangerine's Heathrow Express (74%) and PriestmanGoode's train concept (83%) are by far the highest scorers, followed by DesignworksUSA metro project (44%). In the 2 first cases, it is possible that students relate to the fact seats have tables, in order to associate them with a space to work and to eat while traveling, hence bringing the home and work environments together. This is also true for the colors, materials and finish used in these two projects, as they are based in dark carpeting and textured fabrics which one would see in a living room or in an office environment. So, it is probably the combination of these features, that helps define the way the form language in these projects communicates a certain functionality / performance.

1.7 *Results #3*

Data analysis #3 intended to check for constants and/or changing elements between Almadesign studio projects and competitors' projects, in order to establish possible patterns. Students developed 25 Moodboards, one for each project, in three categories: Airline, Private Jet and Railway. Some reference categories were included in the brief, so that the students could look for images which related to the form language of the projects in several areas:

- Product Design
- Architecture
- Fashion Design
- Movies
- Comics

The "Moodboards" expressed the references the students identified in the projects, after some reflection and group discussion. This provided a visual analysis of the design languages used in different projects. The final outcome were 25 "Moodboards" representative of the selected projects. In the next pages, the Moodboards will be shown and commented in each on the 3 project categories: airline, private jet, railway. In each category, Almadesign project will be analyzed and compared against competitors' projects. Although 25 Moodboards were developed (see Annexes) only 15 will be considered in this document, 5 for each sequence of projects in a category.

1.7.1 Project newFACE

Below, in Figure 98, one of the Moodboards referring to project Boeing 787 (Teague), with the specific keywords (translated from the Portuguese) is depicted:

- Minimal
- Spaceship
- Spacious
- Organic
- Comfort
- Futuristic
- Simple
- Efficiency

Figure 98 : Moodboard for Airline project (Boeing 787 developed by students (source: researcher, 2015)

In Figure 99 we can see the Moodboard referring to project newFACE (Almadesign), with the specific keywords (translated from the Portuguese):

- Clean
- Bright
- Spacious
- Luxury
- Relaxation
- Comfort
- Futuristic

Figure 99 : Students' Moodboard for Airline project (newFACE – Almadesign) (source: researcher, 2015)

In Figure 100, we can see the Moodboard referring to project Embraer EJETS 2 (PriestmanGoode), with the specific keywords (translated form the Portuguese):

- Traditional
- Bright
- Comfort
- Positive
- Hospitable
- Retro

Figure 100 : Student's Moodboard for Airline project (EJET2 - Priestman Goode) (source: researcher, 2015)

In Figure 101, we can see the Moodboard referring to project Dove seating concept (JPA), with the specific keywords (translated form the Portuguese):

- Clean
- Peaceful
- Comfort
- Organized
- Soft
- Individual
- Efficient

Figure 101: Students' Moodboard for Airline project (Dove seating concept - JPA) (source: researcher, 2015)

Finally, in Figure 102, the Moodboard referring to project A330 Business Class (Tangerine), with the specific keywords (translated from the Portuguese) is depicted:

- Darkness
- Symmetry
- Individualism
- Rubber
- Silence
- Closed

Figure 102: Students' Moodboard for Airline project (A330 - Tangerine) (source: researcher, 2015)

1.7.2 Project LIFE

Below we can see the Moodboard (Figure 103) referring to project LIFE (Almadesign), with the specific keywords (translated from Portuguese):

- Future
- High-Tech
- Galaxy

Figure 103 : Students' Moodboard for Private Jet project (LIFE - Almadesign) (source: researcher, 2015)

Below we can see the Moodboard (Figure 104) referring to project Mercedes VIP Cabin (Mercedes Design), with the specific keywords (translated from Portuguese):

- Business youth
- Masculine
- Private

Figure 104 : Students' Moodboard for Private Jet project (Mercedes VIP Cabin) (source: researcher, 2015)

Figure 105 refers to project Embraer Lineage 1000 (Priestman Goode), with the specific keywords (translated from Portuguese):

- Traditional
- Cozy
- Social
- Family

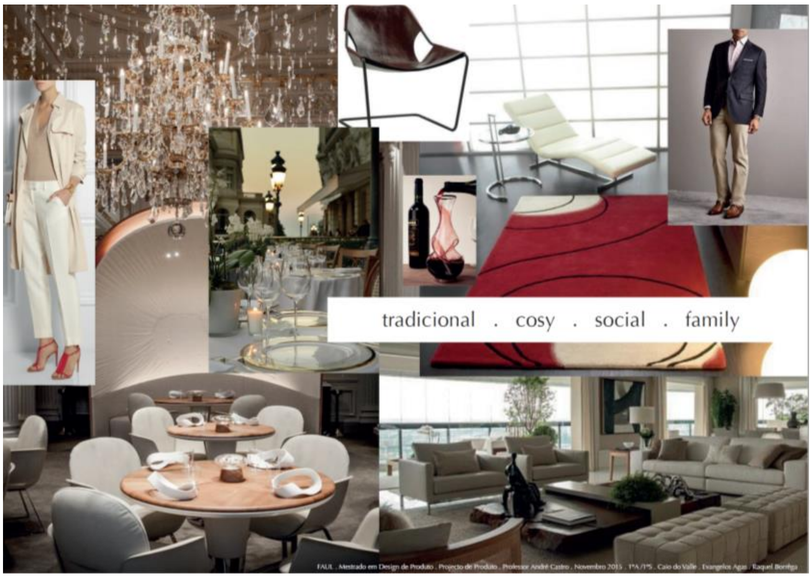


Figure 105 : Students' Moodboard for Private Jet (Lineage – PriestmanGoode) (source: researcher, 2015)

Figure 106 refers to the Moodboard developed for project Embraer Legacy 450 (Embraer Design), with the specific keywords (translated from Portuguese):

- Minimalist
- Business
- Exclusive
- Sober

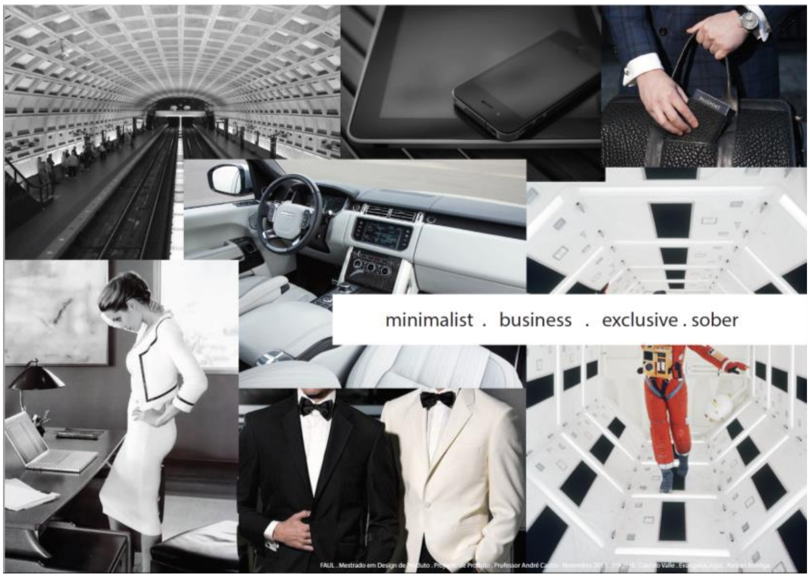


Figure 106 : Students' Moodboard for Private Jet project (Legacy 450 - Embraer) (source: researcher, 2015)

Finally, Figure 107 depicts the Moodboard referring to project Bombardier Global 8000 (Bombardier Design), with the specific keywords (translated from Portuguese):

- Senior
- Easy going
- Home
- Comfort

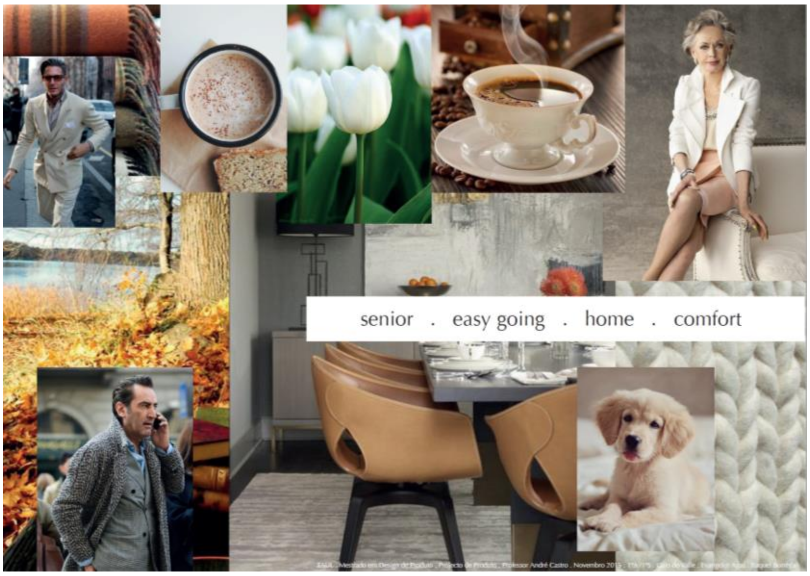


Figure 107: Students' Moodboard for Private Jet project (Bombardier Global 8000) (source: researcher, 2015)

1.7.3 Project inTRAIN

In Figure 108 the Moodboard referring to project Heathrow Express (Tangerine) is presented, with the specific keywords (translated from Portuguese):

- Spacious
- Urban
- Exquisite
- Comfort

Figure 108 : Students' Moodboard for Railway (Heathrow Express Tangerine) (source: researcher, 2017)

Figure 109 presents the Moodboard referring to project Mercury Concept (Priestman Goode), with the specific keywords (translated from Portuguese):

- Spacious
- Urban
- Exquisite
- Comfort

Figure 109 : Students' Moodboard for Railway project (Mercury – Priestman Goode) (source: researcher, 2015)

Figure 110 depicts the Moodboard referring to project inTRAIN (Almadesign), with the specific keywords (translated from Portuguese):

- Fluid
- Nature
- Ramification
- Spacious

Figure 110 : Students' Moodboard for Railway project (inTRAIN - Almadesign)s (source: researcher, 2015)

Figure 111 features the Moodboard referring to project Siemens Inspiro Metro (Designworks), with the specific keywords (translated from Portuguese):

- Cold
- Rigid
- Spacious
- Artificial

Figure 111 : Students' Moodboard for Railway project (Inspiro – BMW Designworks) (source: researcher, 2015)

Finally, Figure 111 presents the Moodboard referring to project High-speed Commuter Train (JPA), with the specific keywords (translated to Portuguese):

- Transparent
- Water
- Compact
- Bright

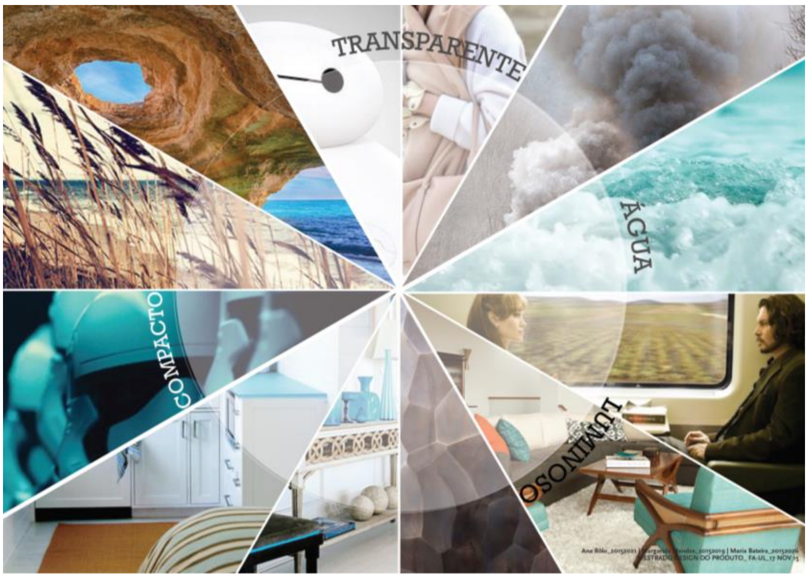


Figure 112 : Students' Moodboard for Railway project (High-speed train - JPA) (source: researcher, 2015)

1.8 ***Discussion***

1.8.1 Revision of the hypothesis

Part III - Chapter 1 presented the work developed for Experimental study #1: “Reverse inspiration: educational approach on the analysis of form language in design studios”. It includes the Objectives, Methodology, Results and Conclusion. The following objectives were set (and partially achieved) for Experimental study Study #1:

- To compare Almadesign Studio Form Language with other competitor studios, trying to discover possible common elements, differences, constants: it is considered that this objective was partially achieved, by comparing typologies of keywords used for the classification of each project
- To semantically analyze the Form Language of Almadesign in an educational environment: this was achieved by working with students in a Master Design course exercise, using images and keywords as a first means of analysis for each project.
- To analyze the Form Language and try to use a “reverse inpiration” process trying to deconstruct inspiration and references which led to the project’s language: this was achieved through the development of moodboards for each of the projects.
- To reframe (or not) the investigation question according to the results: the initial hypothesis was confirmed.

1.8.2 Project newFACE

Overall, when looking at the data collection and results, we can argue that project newFACE was considered by students as being a project which clearly communicates specific messages with its Form Language. Main keywords referenced include the concepts of “NATURE” and “CONFORT”. When we group similar words into specific categories, 3 appear as the most mentioned: again “NATURE” (including words such as forest, sky, colour, nature, etcetera) clearly stands out when compared to other 4 projects (71%) of the references, followed by the “SCI-FI” concept (including words such as Starwars, space, tunnel, sci-fi, etcetera) which accounts for 19% of the word percentage and, finally, the “COMFORT” category (including words like clean, airy, lightness, bright, fresh, comfortable) which accounts for 8% of the percentage. The Moodboards developed confirm this information, repeating most words already selected (clean, bright, spacious, relaxation, comfort, futuristic).

Regarding the hypothesis, we can clearly state that this specific project communicates a specific Form Language which is different from the one developed by the competitors and which heavily relates with NATURE and SCI-FI (FUTURISTIC) concepts.

1.8.3 Project LIFE

Overall, when looking at the data collection and results, we can argue that project LIFE was considered by students as being a project which also clearly communicates specific messages with its form language. Main keywords referenced include the concepts of “FUTURISTIC”, “SCI-FI” and “HONEYCOMB”. When we group similar words into specific categories, 3 appear as the most mentioned: again, we can refer to “SCI-FI” with 46% of the words collected (in which we included futuristic, spaceship, planet, high-tech, hologram), “NATURE” with as much as 32% of the words collected (in which we included words such as honeycomb, organic, dawn, nature), “CONFORT” with 13% (including comfortable) and HOME-WORK with 9% (including words workspace, power, technology). The Moodboards developed confirm this information, mentioning some of the same words such as Future (Futuristic), High-Tech, Galaxy.

Regarding the hypothesis, we can clearly state that this specific project communicates a Form Language which is different from the one developed by the competitors and which is connected to SCI-FI (FUTURISTIC) and NATURE concepts.

1.8.4 Project inTRAIN

Overall, when looking at the data collection and results, we can argue that project inTRAIN was considered by students as being a project which also clearly communicates specific messages with its Form Language. Main keywords referenced include the concepts of “SPACIOUS”, “NATURE” and “COMFORTABLE” with direct references to the projects function and performance “METRO”. When we group similar words into specific categories, 2 appear as the most mentioned: again, we can refer to “NATURE” with 64% of the words collected (in which we included branches, life, movement, organic, breathable, etc), “COMFORT” with as much as 22% of the words collected (in which we included words such as bright, spacious, warm, clean, etc). In this case we could also trace words relating to “HOME-WORK”, 8% and “SCI-FI” with 6%. The Moodboards developed confirm this information, mentioning some of the same words such as Nature, Ramification, Fluid and Spacious.

Regarding the hypothesis, we can clearly state that this specific project communicates a Form Language which is different from the one developed by the competitors and which is connected to NATURE and CONFORTABLE perception.

1.8.5 Synthesis of the chapter

It is considered that the main objectives of Study #1 were completed. A first attempt to semantically analyze the Form Language of Almadesign was made in an educational environment. The Form Language was also compared between the studio’s and other competitors. A “reverse inspiration” process was used to deconstruct the design process, getting more information on possible inspiration and references which could have led to the project’s Form Language. The hypothesis was confirmed, based on the evidence collected in the study of the 15 projects:

- “It is possible to identify and characterize a specific Form Language developed in Almadesign”

In light of these results, the Hypothesis was reframed, adding complexity layers with 3 investigation vectors, Context, Syntax and Semantics:

- “It is possible to identify a specific Form Language developed in Almadesign studio and characterize it through different complexity levels: a changing Context (social, technological and market), a Form Syntax (design elements and their organization through design principles) and a Form Semantics (symbolic elements perceived and interpreted by clients and partners).”

Table 10 in the next page sums up the main findings of this chapter.

Table 10 - Experimental Study #1: Summary of results

<table>
<tr><th colspan="5">EXPERIMENTAL STUDY STUDY #1 - REVERSE INSPIRATION: SUMMARY OF RESULTS</th></tr>
<tr><th>Data</th><th>Results</th><th>newFACE project</th><th>LIFE project</th><th>inTRAIN project</th></tr>
<tr><td>Data gathered</td><td>1250 Keywords
25 Moodboards (images and keywords)</td><td></td><td></td><td></td></tr>
<tr><td>Analysis #1</td><td>Keywords for Almadesign Studio projects grouped by frequency; visualization of results via tag crowd software;</td><td></td><td></td><td></td></tr>
<tr><td>Analysis #2</td><td>Keywords grouped by categories; % of each category compared between Almadesign studio projects and competitor projects;</td><td colspan="3">
<table>
<tr><td>SCI-FI</td><td>19%</td><td>46%</td><td>6%</td></tr>
<tr><td>NATURE</td><td>71%</td><td>32%</td><td>64%</td></tr>
<tr><td>COMFORT</td><td>8%</td><td>13%</td><td>22%</td></tr>
<tr><td>HOMEWORK</td><td>2%</td><td>9%</td><td>8%</td></tr>
<tr><td>TOTAL</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table></td></tr>
<tr><td>Analysis #3</td><td>Moodboards were gathered in a single document; qualitative analysis and comparison between Almadesign projects and competitor's projects;</td><td></td><td></td><td></td></tr>
</table>

(source: researcher, 2017)

2 Experimental Study #2: Box of Favorite Things

2.1 *Introduction*

Study #2 was named "Box of Favorite Things". The title is inspired by Charles and Ray Eames experiences with collaborative, educational tools. The research team tried to build a fun, colaborative exercise which could collect important data about the studio designer's visual culture and design references.

2.2 *Objectives*

The following objectives were set for Experimental Study #2:

- To collect a series of visual culture references which make up a "box of favorite things" of the studio's current designers (and also a few ex-designers)
- To debate the selection with the designers in order to understand their choices, visual culture and references.
- To cross the collected data with results from Experimental Study #1 and try to establish bridges (isolate constants, tendencies) between the studio's Form Language and the designers' own visual culture and background references.

As the second experimental study, it was fundamental for the investigation to gather information about designers working at the studio but also from ex-designers who had spent a considerable part of their careers working for Almadesign and whose influence in the overall culture, methodologies and process could be relevant in identifying and characterizing a specific Almadesign Form Language.

2.3 *Methodology*

2.3.1 Dates, participants and sample size

Experimental study #2 was developed in the period from the 1st October 2016 to 15th February 2017. During this period, several tasks were tackled in the investigation such as Planning Activities, Literature Review and Empirical Investigation activities. Experimental study #2 was prepared by the research team during the month of October, when a template to fill in was sent to 14 participants (13 plus the researcher himself). The information was gathered, with 14 templates filled in, and a Workshop session was prepared in the first weeks of December. A three hour session with studio designers was then prepared and implemented on the 28th December 2017, at the company's headquarters in Paço de Arcos, Oeiras. The session included the use of "printed cards", prepared by the research team, which included designer's "favorite things". These cards were exhibited and explained by each designer to their colleagues. In the end of the session a debate was held on the results of the designer's choices. The session was photographed and notes were taken by the researcher during the presentations.

2.3.2 Evaluation approach

Experimental Study #2 was a Qualitative study with professional designers conducted during a period of 4 weeks and a presentation and discussion session at the studio. The following chart summarizes the evaluation approach developed by the researcher, determining the following aspects:

- Type of study
- What needs to be measured
- Data collection method
- Access issues / Tools
- Timeline
- What was done

Table 11 - Experimental Study #2: Evaluation approach

EXPERIMENTAL STUDY #2 – EVALUATION APPROACH					
Type of study	**What needs to be measured**	**Data to be collected and collection method**	**Access issues / Tools**	**Timeline / Venue**	**What was done**
Qualitative study with design professionals conducted during a specific timeframe and a presentation and discussion session at Almadesign studio	Visual culture and form language references of Almadesign designers (current and former)	Images + Keywords; Discussion comments; Template filled in by designers; Presentation session at Almadesign; Part of the sessions recorded in video; Notes taken by the researcher	Research was conducted in 2 phases: designers were asked to fill in a template; a session was organized where designers presented their choices and a group discussion was developed;	Almadesign Studio headquarters in Paço de Arcos; October 2016 to February 2017; Session at Almadesign was held in December 2016;	A template for designers to fill in was developed, distributed and collected; Data was organized in printed cards which were then used in a presentation session at Almadesign in Paço de Arcos; Preliminary conclusions were collected: Word count for quantitative analysis; Images selection for qualitative analysis;

(Source: researcher, 2016)

2.3.3 Procedure

Experimental study #2 was launched via an e-mail request sent to 13 current (and former) Almadesign studio designers. The name of the study "Box of favorite things" was mentioned was well as its integration in the PhD research on the "Form Language of Almadesign". The designers' collaboration was asked in order to collect a series of design references chosen by each one of the designer, projects and objects related to visual culture which would reflect their own personalities, way of designing, personal tastes, with focus on the essential form references which would have a special meaning for each one of the designers. Designers were asked to make individual choices which had a significant impact on their careers as designers and not to share their choices with colleagues so as to not influence others choices. It was also mentioned that the most important thing was for each designer to choose his own "favorite things" so that in the end the choices would reflect a unique, personal, visual culture. In order to organize the selection, but also to keep it contained in a fixed number of choices, a set of specific areas was defined for designers to choose examples from. The following areas were selected:

- Transportation Design; Product design; Fashion design
- Architecture; Movie/Cinema; Animation/Comics;
- Arts; Nature; Future;

For each of these areas, designers were asked to reflect on a favorite object / project / design, to choose one image to illustrate it and up to three keywords to describe it. After completion, they would send back the template to the researcher. From the initial 14 designers (13 + researcher), 13 complete templates were received + one extra template, which was filled in by the founder of the company. This meant that his influence over two decades of project development, would be more clearly stated by having 2 templates filled in: one with choices from his early years as a design student, and one form the latest years.

The categories chosen by the research team were based on the type of design work developed at Almadesign (mainly Transport Design, Product and Interior Design) and also by analyzing previous conclusions from Experimental study #1, where for instance, a lot of references to Sci-Fi, Nature were made. The 10 categories were included in the template, which was distributed via e-mail to the designers along with a brief which explained the context of the investigation and the main activities to be performed. A four-week period was given to the designers, after which the information was collected by the researcher and a presentation session was prepared. The following Figure 113 shows a preview of the template distributed to the designers:

Figure 113 : Template distributed to the designers (source: the researcher, 2016)

2.4 ***Data Collection***

A presentation session was held at Almadesign in December 2016. The following information was gathered:

- 14 completed Templates;
- Participation and results from 13 designers (the CEO presented 2 templates);
- A library of 140 images representing the designer's choices and a list of 420 keywords;

Figure 114 and Figure 115 show examples of the choices made by two studio designers: one who worked at Almadesign from the period of 2001 to 2009; another who has been working at the studio from 2007 and is still currently a designer at Almadesign.

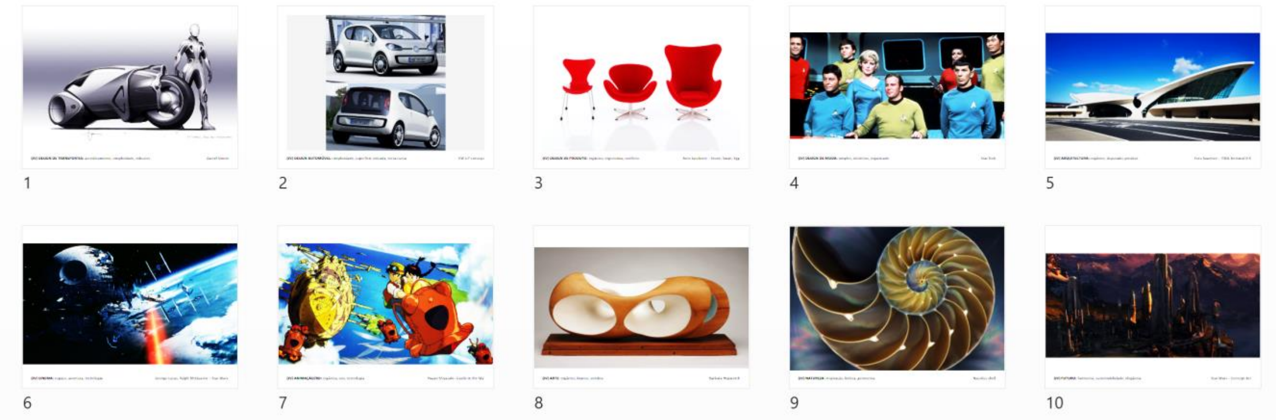


Figure 114 : "Box of Favorite Things": ex-designer choices for the 10 categories (source: researcher, 2016)

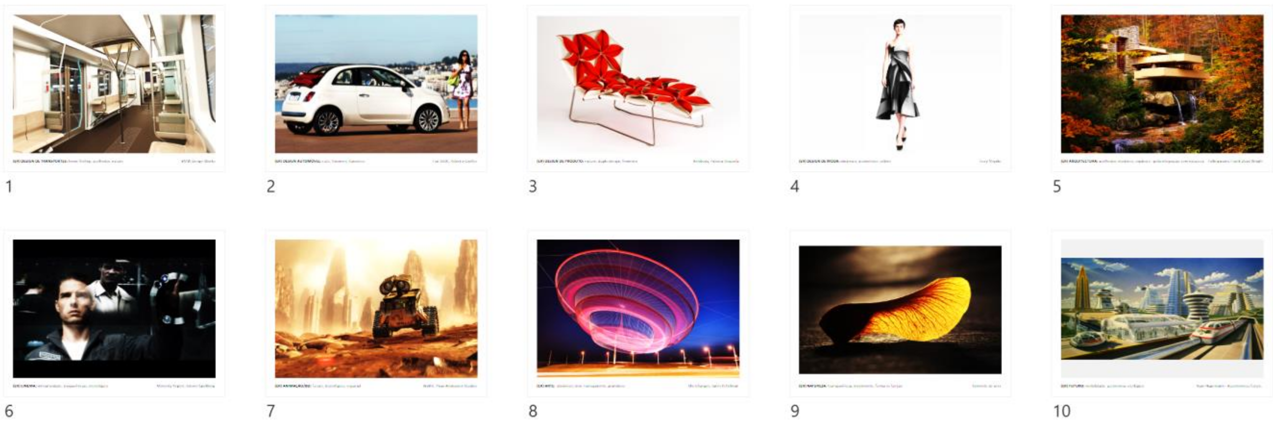


Figure 115 : Current designer's choices for the 10 categories (source: researcher, 2016)

Figure 116 is an example of the Spreadsheet containing the Qualitative analysis (see Annexes for complete chart). The following filters were used to organize the information:

- Theme (Transport design; Product design; Fashion design; Architecture; Cinema; Comics; Art; Nature; Future)
- Favorite Thing (the choice of project by each designer)
- Number (to achieve counting using a conventional spreadsheet software tool)
- Keywords (to isolate constant themes or word repetition, etcetera);

Theme	Favourite Thing	Nr.	Key Words	Nr.
Transportation	Embraer EJETS Cabin Priestman Goode	1	Function	1
			High-tech	1
			Sofisticated	1
Automotive	La Ferrari Ferrari Design Studio	1	Emotion	1
			Performance	1
			Sculture	1
Product	Chair X Ross Lovergrove	1	Organic	1
			Material and Technology	1
			Elegance	1
Moda	NIKE X	1	Material and Technology	1
			Layers	1
			Color	1
Architecture	Performing Arts Centers Dubai Zaha Hadid	1	Fluid	1
			Transparent	1
			Emotion	1
Cinema	Star Wars George Lucas	1	Future city	1
			Vehicle	1
			Entertainment	1
Animation /BD	Bilal		Color and light	1
			Sensuality	1
			Retrofuturismo	1
Art	Henry Moore	1	Leveza	1
			Fluidez	1
			Sensualidade	1
Nature	Amazónia	1	Exotismo	1
			Textura	1
			Relaxante	1
Future	Ilha flutuante	1	Tecnologia	1
			sustentabilidade	1
			optimização	1
Transportation	Concorde	1	rapidez	1
			Optimismo	1
			tecnologia	1
Automotive	La Ferrari Ferrari Design Studio	1	arrojado	1
			futurista	1
			arquitectónico	1
Product	Braun - shaver Dieter Rams	1	racional	1
			minimal	1
			bauhaus	1
Moda	Watch Longines	1	sofisticado	1
			tecnológico	1
			sóbrio	1

Figure 116 : Designer’s choices: 14 boards, 140 choices, 420 keywords (source: researcher, 2016).

Based on this choice of each designer, a set of “10 Cards” for each designer was prepared with its 10 choices and respective keywords in A5 format. The cards were prepared with magnets on the back so that they could be easily placed in a board and moved around for different types of organization. A session at Almadesign Studio was developed in which the designers presented their work to colleagues, followed by a short debate. The cards methodology was considered to be a flexible, fun tool to use, and designers' feedback was very good. Due to the large amount of data gathered and the great differentes in the descpritive words, the researcher devise the folowing strategy for analysis, presented in Table 12:

Table 12 - Experimental Study #2: "Box of Favorite Things" – Evaluation approach

EXPERIMENTAL STUDY #2 – DATA COLLECTION AND ANALYSIS			
Data gathered	**Data analysis #1**	**Data analysis #2**	**Data analysis #3**
14 Presentations (images and keywords) 140 Images 420 Keywords	Keywords for each category (Transportation, Automotive, Product, Fashion, etc) were organized in a spread sheet with specific filters;	Words were grouped by theme and by frequency with visualization of results via Wordclouds; less frequent keywords were arranged in larger groups	Images were organized in categories (grouping of similar form language choices or typologies of choices) and a global image for each theme was produced;

(source: researcher, 2017)

- **Data analysis #1:** Keywords for each category (Transportation, Automotive, Product, Fashion, etc) were organized in a spread sheet with specific filters;
- **Data analysis #2:** Using a specific software tool, researcher analysed word frequency for each of category (Transportation, Automotive, Product, Fashion, etc). This allowed for a visual comparision and analysis of the word frequency regarding designers choices.
- **Data analysis #3:** Images were organized in categories (grouping of similar Form Language choices or typologies of choices) and a global image for each theme was produced;

For Data Analysis #1 keywords were processed using a Wordcount software (www.tagcrowd.com) and several "Wordclouds" were developed: word frequency for all categories; top 200 words for all categories; top 50 words for each category, etc. The "Wordcloud" methodology allowed for a visual representation of the words selected by the designers during the study (favorite projects in different categories + keywords) and hence brought the visual elements back to the study (from visual references to words and back to graphic references). This was considered to be an interesting tool to help visualize the information and quickly sort out the more frequent references. These words were then used as the base words for developing the Experimental study #3 online survey.

2.5 ***Results***

The Designers feedback was very generally very positive on the exercise, with most stating that it “was very challenging to having to choose only one image per category, with so many existing references…”. There were also comments on the fact that the exercise “demanded a reflection on the processes and personal history of each designer”, which was considered very interesting and challenging.

For the presentation, the researcher printed the images and glued them to a rigid support with a magnet surface, which allowed for the different “cards” of images to be combined and recombined in magnetic boards for the presentation. The presentation was photographed and notes were taken by the researcher. Each designer described his own choice of images using about 10 minutes. There were 7 designers presenting the work and another templates were presented by fellow colleagues from Almadesign team, who read the keywords written on the cards to describe the designer’s choices.

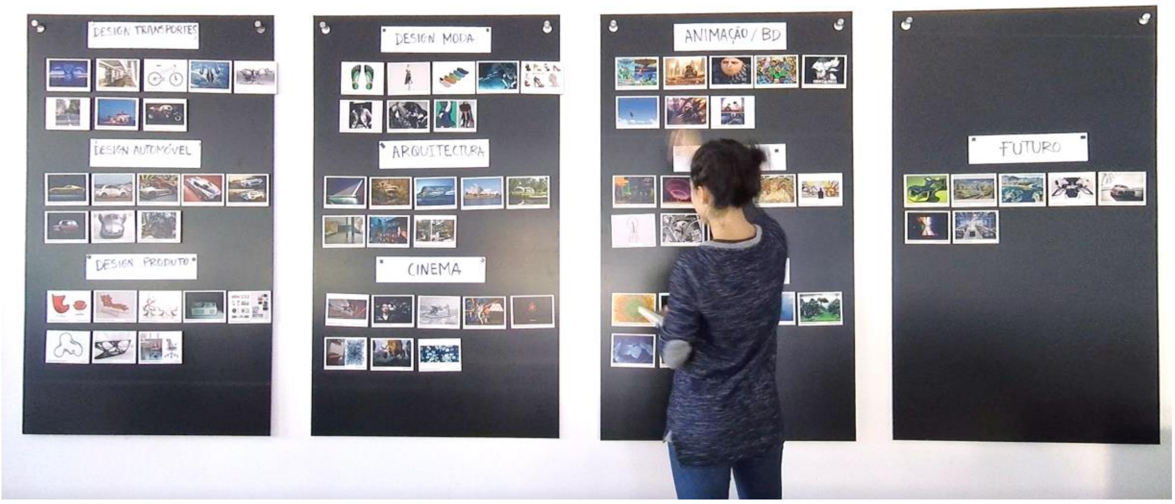


Figure 117 : Session at Almadesign studio (source: researcher, 2016)

A preliminary analysis of the results of the exercise was developed by the researcher. Three types of analysis were made as already mentioned. The first was a quantitative analysis of the keywords defined by the Designers for each separate category with a wordcloud image based on the listing of keywords (translated from Portuguese to English by the author). The results can be visualized in the following figures, the first of each gathers the top 233 words for every category. The following images show the different wordclouds for each of the category.

Figure 118 to Figure 137 show different wordclouds per category / themes: Transport design; Product design; Fashion design; Architecture; Cinema; Comics; Art; Nature; Future. Following the 10 wordclouds, a general wordcloud including the Top 233 keywords is also presented.

2.5.1 Transport design

Designers' choices for Transport Design included several design projects: Three main groups can be defined and "tagged" according the researcher own criteria (between parenthesis):

- High performance aircraft (TECHNOLOGICAL)
- Transport interiors (ORGANIC)
- Bicycles and motorbikes (MINIMAL)

Overall, we can see that a few words were repeated such as DETAILED, FUNCTIONAL, LIFESTYLE, MINIMAL, ORGANIC and TECHNOLOGICAL. In trying to group the remaining keywords we can conclude that about 30% of the words refer to TECHNOLOGICAL which is, of course, very important in the performance (functionality) of transport design products. We propose to group the words in the following categories:

- TECHNOLOGICAL: aerodynamic, autonomous, disruptive, futuristic, high-tech, innovative, jetengine, science fiction, speed, stealth (which we directly associate to aircraft)
- ORGANIC: nature, fluid, bionic (associated with aircraft interiors, railway interiors and boat)
- MINIMAL: timeless, sophisticated, simplicity (associated with bikes and VW van)

Figure 118 presents the Wordcloud, followed by Figure 119, which presents the images chosen (see Anexes for larger size images).

Figure 118 : Transport design wordcloud (source: researcher, 2017, www.tagcrowd.com).

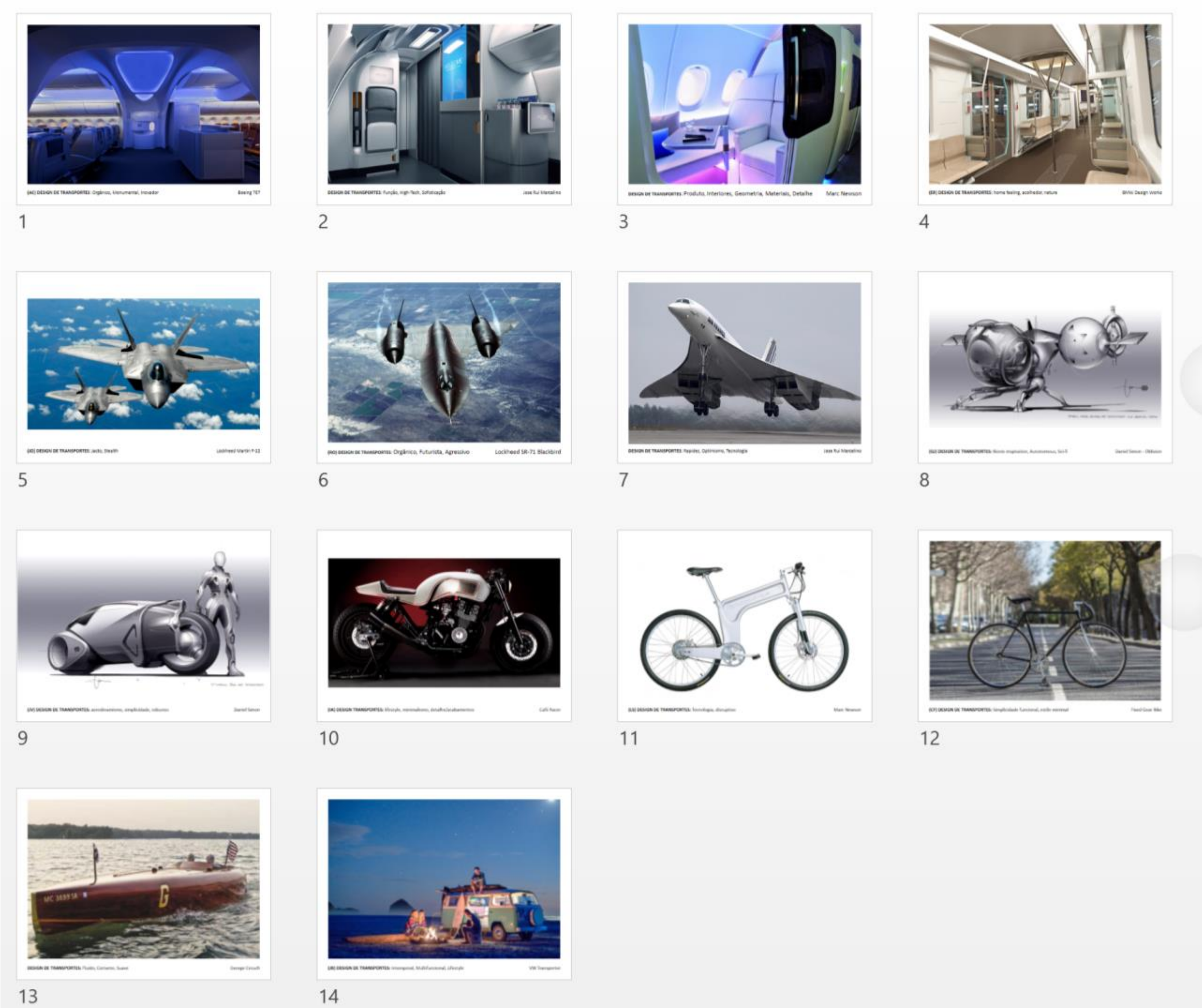


Figure 119 : 14 choices for Transport Design theme (source: researcher, 2016)

2.5.2 Automotive design

Designers choices for Automotive Design included several design projects, from prototype sports cars, to production utilitarian vehicles. Two big groups can be defined:

- High performance cars (INNOVATIVE)
- "Cute" (ICONIC)

Overall, we can see that a few words were repeated such as INNOVATIVE, ICONIC and SIMPLE. The remaining words are very broad, but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- INNOVATIVE: conceptual, dynamic, emotion, engaged, daring, dynamic, futuristic, sculture, performance, wow, supersonic
- ICONIC: anthropomorphic, cute, simple, feminine, friendly, organic, retro, simple, simplicity, small, utilitarian

Figure 120 presents the Wordcloud, followed by Figure 121, which presents the images chosen (see Anexes for larger size images).

Figure 120 : Automotive design wordcloud (source: researcher, 2017, www.tagcrowd.com).

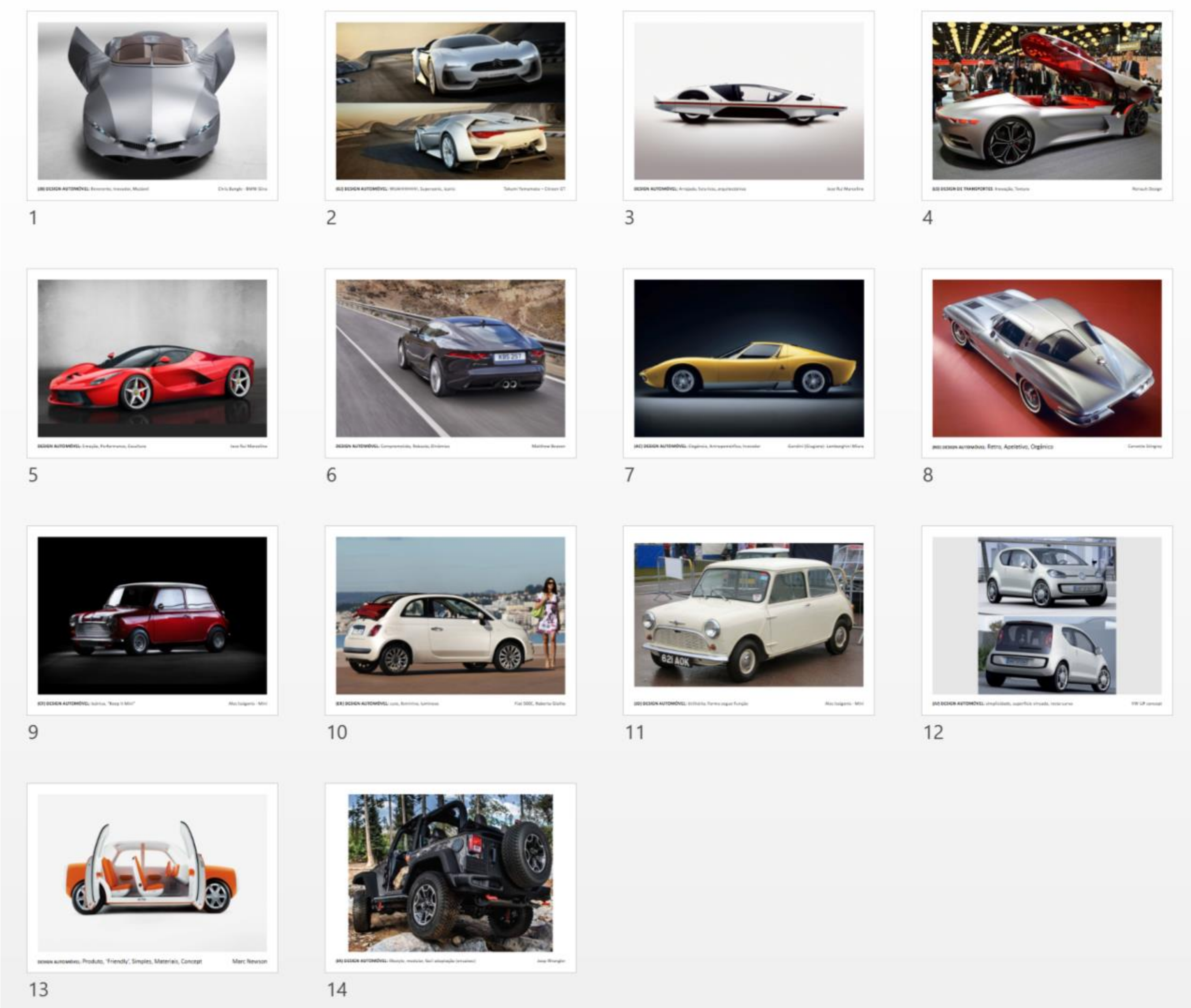


Figure 121 : 14 choices for Automotive Design theme (source: researcher, 2016)

2.5.3 Product design

Designers' choices for Product Design included several design projects, from chairs to electrical appliances to tables and home accessories. Two big groups can be defined:

- Chairs (ORGANIC)
- Electrical appliances (MINIMAL)

We can conclude that Dieter Rams's products for Braun are considered by a great majority of designers as the reference products. A few words were repeatedly used to define the choices such as ORGANIC, FUNCTIONAL, MINIMAL, TIMELESS, NATURE, FEMININE and finally, MATERIALS. The remaining words are very broad, but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- ORGANIC: feminine, nature, bonestructure, confortable, ergonomic
- FUNCTIONAL: minimal, timeless, honest, iconic, rational, simple, bauhaus

Figure 122 presents the Wordcloud, followed by Figure 123, which presents the images chosen (see Anexes for larger size images).

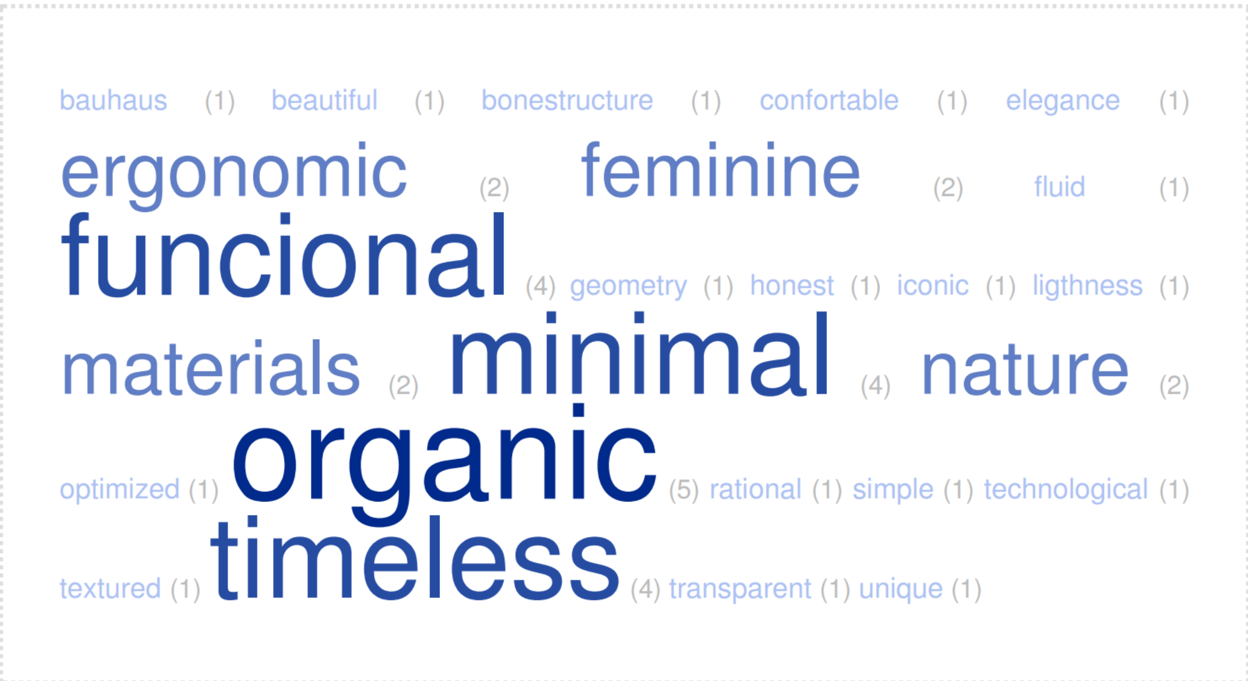


Figure 122 : Product design wordcloud (source: researcher, 2017, www.tagcrowd.com).

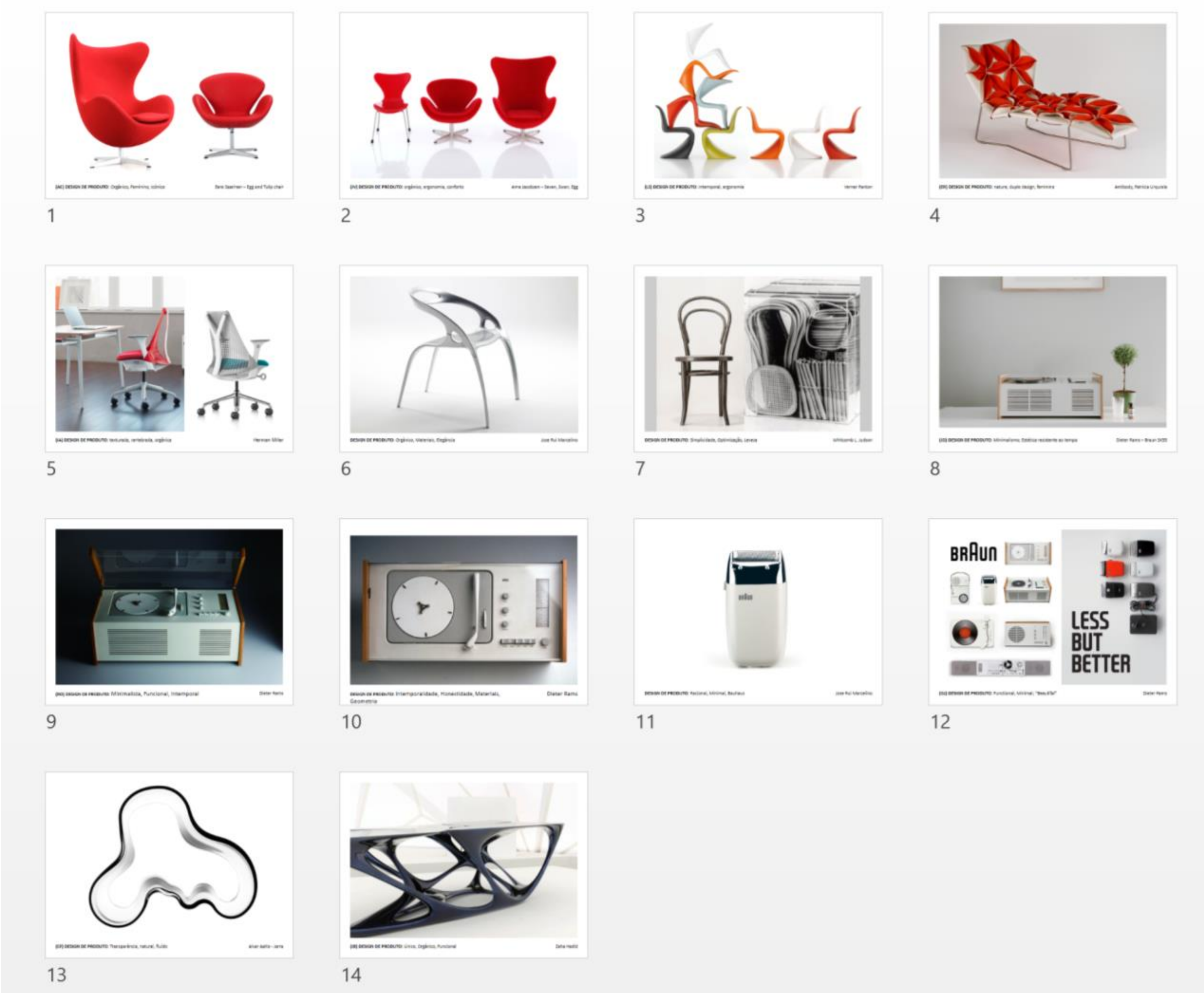


Figure 123 : 14 choices for Product Design theme (source: researcher, 2016)

2.5.4 Fashion design

Designers' choices for Fashion Design included several design projects, from shoes to haute couture to sci-fi costume design and sports clothing. Three big groups can be defined:

- Shoes (and sports clothing) (MATERIALS)
- Sci-fi costume design (TECHNOLOGICAL)
- Haute couture (SOBER)

Choice of keywords is varied, with a few words repeatedly used to define the choices such as TECHNOLOGICAL, MATERIALS, COLORS, PERFORMANCE, SOBER and CONFORTABLE. The remaining words are very broad, but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- TECHNOLOGICAL: materials, performance, bionic, innovative, futuristic, dynamic,
- SOBER: simple, sophisticated, stylish, timeless, distinctive

Figure 124 presents the Wordcloud, followed by Figure 125, which presents the images chosen (see Anexes for larger size images).

Figure 124 : Fashion design wordcloud (source: researcher, 2017, www.tagcrowd.com).

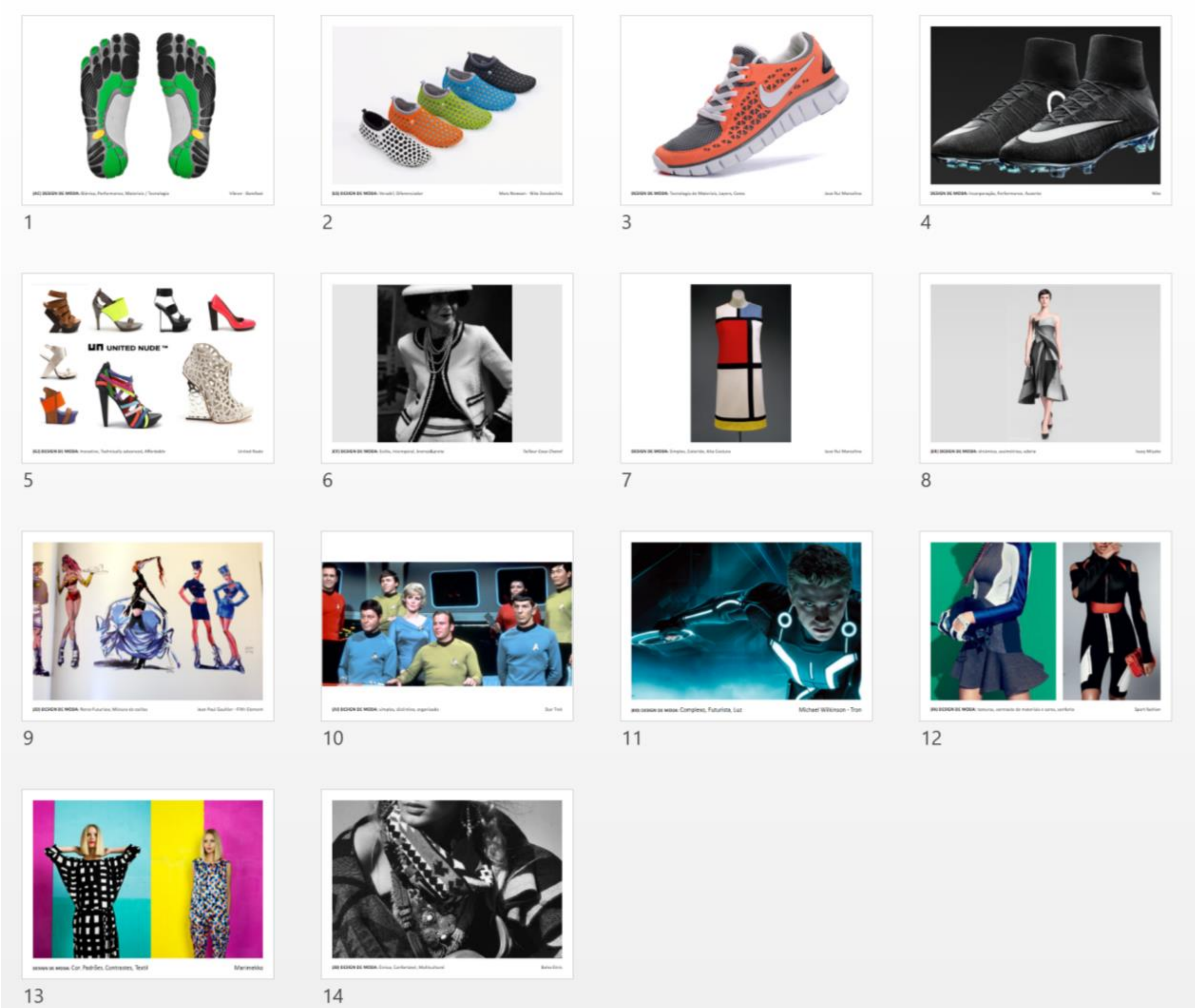


Figure 125 : 14 choices for Fashion Design theme (source: researcher, 2016)

2.5.5 Architecture

Designers' choices for Architecture included several projects, from bridges to museums, private houses to public buildings. Two different projects were chosen twice, Zaha Hadid's "Abu Dhabi Performing Arts Centre" and Frank Lloyd Wright "Falling Water". Two big groups can be defined:

- Nature inspired (antopomorphic and parametric form languages) (ORGANIC)
- Modernism (modular approach and nature integration (MODULAR)

Choice of keywords is varied, with a few words repeatedly used to define the choices such as ORGANIC, NATURE, MODULAR, RACIONAL and TRANSPARENT. The remaining words are very broad, but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- ORGANIC: nature, transparent, antropomorphic, emotion, fluid, futuristic, plasticity
- RATIONAL: nature integration, modular, minimal, modernism

Figure 126 presents the Wordcloud, followed by Figure 127, which presents the images chosen (see Anexes for larger size images).

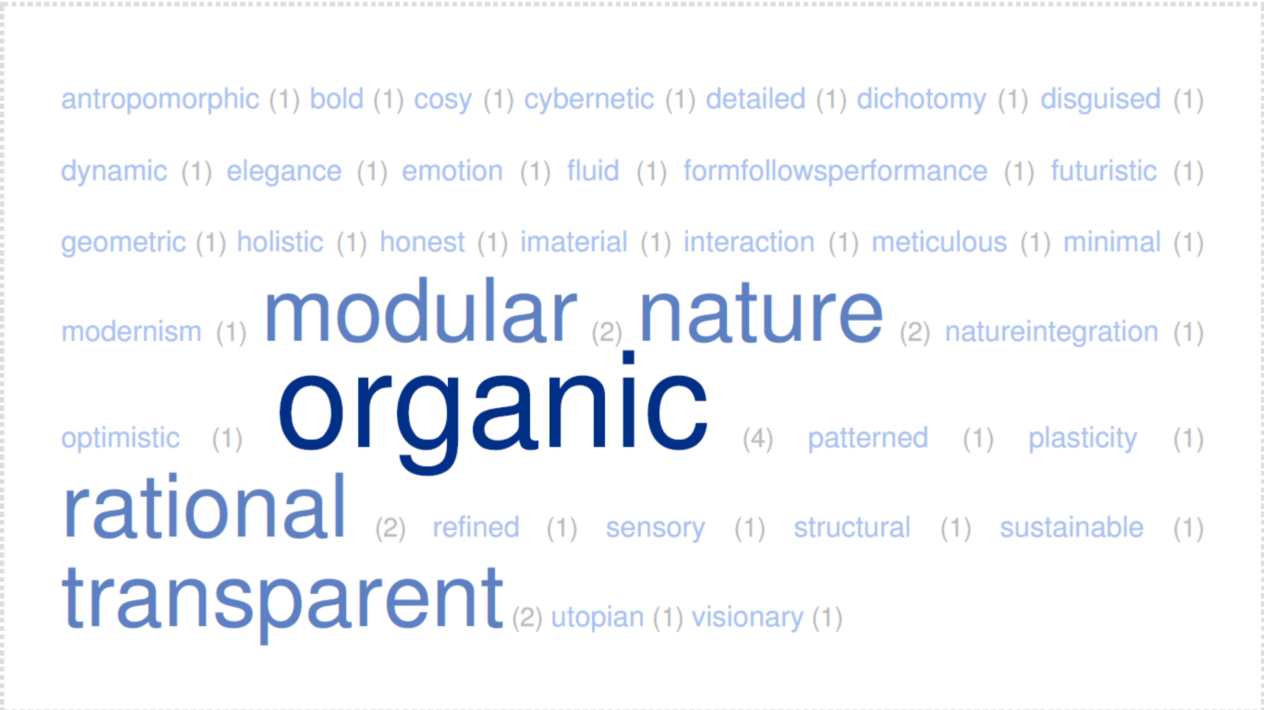


Figure 126 : Architecture wordcloud (source: researcher, 2017, www.tagcrowd.com).

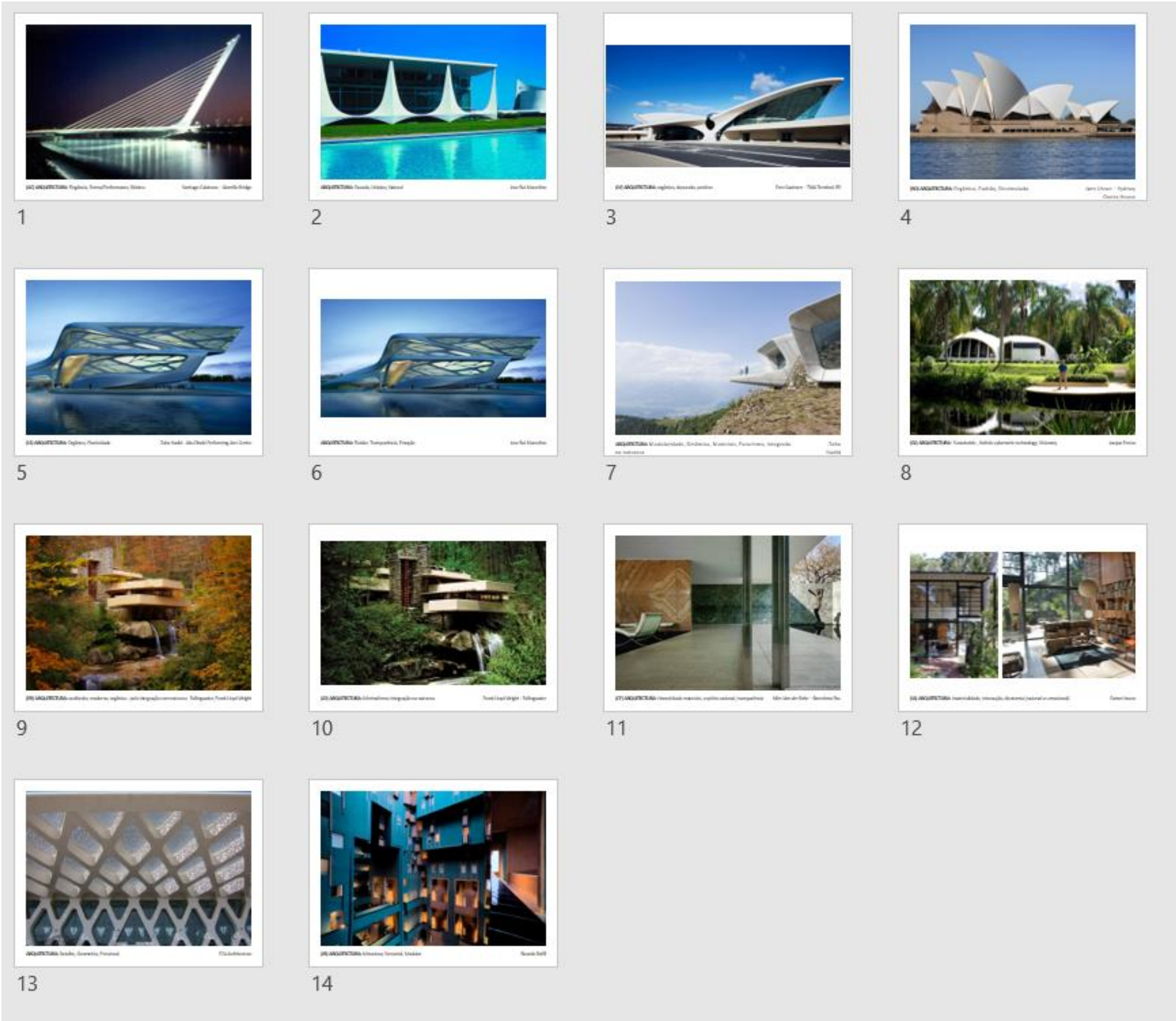


Figure 127 : 14 choices for Architecture theme (source: researcher, 2016)

2.5.6 Cinema / Movies

Designers' choices for Movies included several projects, mainly SCI-FI movies. Two movies were chosen more than one time: Starwars and Blade Runner. Three major groups can be defined:

- SCI-FI in space (FUTURISTIC)
- SCI-FI in earth
- ACTION MOVIE (ADVENTURE)

Choice of keywords is varied, with a few words repeatedly used to define the choices such as FUTURISTIC, TECHNOLOGICAL, ENTERTAINING, ADVENTURE. The remaining words are varied but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- FUTURISTIC: technological, artificial, space, cyberpunk, distopian, fantastical, out-of-the-box, uniquitous computing
- ADVENTURE: entertaining, attitude, heritage, iconic

Figure 128 presents the Wordcloud, followed by Figure 129, which presents the images chosen (see Anexes for larger size images).

Figure 128 : Cinema / Movies wordcloud (source: researcher, 2017, www.tagcrowd.com).

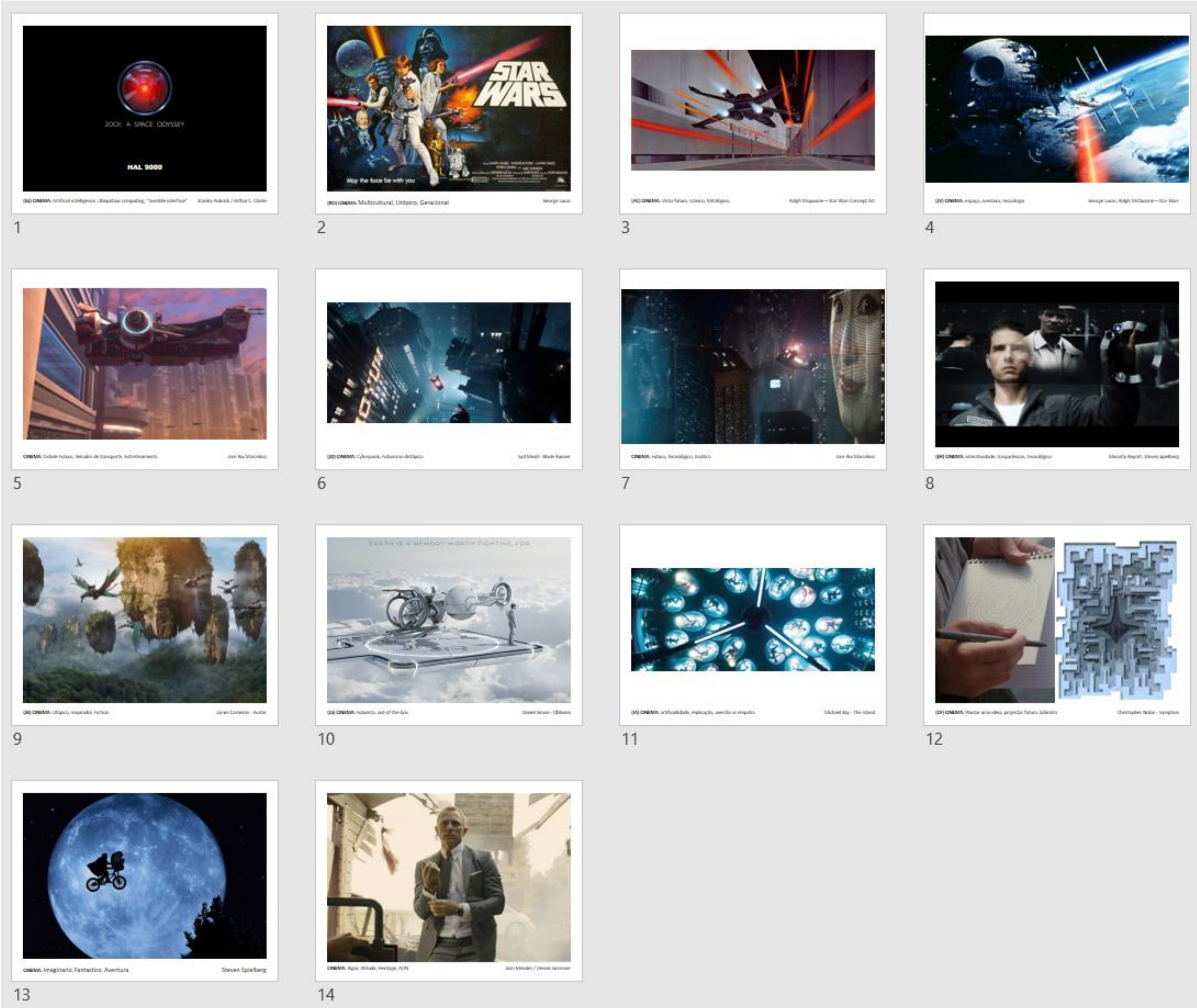


Figure 129 : 14 choices for Movies / Cinema theme (source: researcher, 2016)

2.5.7 Comics / Animation

Designers' choices for Comics and Animation included several projects, mainly SCI-FI animation movies and comic books. Five choices were repeated more than one time: "Ghost in the Shell", "Hayako Miazaki", "Bilal", "Wall-E" and "Calvin and Hobbes". Four major groups can be defined:

- Japonese Anime (AUTOMATION)
- Franco-belge Comics (FUTURISTIC, APOCALYPTIC)
- USA Comics (WIT)
- Animation movies (FUTURISTIC, WIT)

Choice of Keywords was varied, with a few words repeated such as FUTURISTIC, TECHNOLOGICAL, DYNAMIC, AUTOMATION, AVIATION and WIT. The remaining words are varied but a tentative grouping can possibly be achieved. We propose to group the words in the following categories:

- FUTURISTIC: technological, apocalyptic, automation, cyborg, dystopian, sci-fi, fantastic, technology vs nature
- WIT: humor, satire, character, irreverence

Figure 130 presents the Wordcloud, followed by Figure 131, which presents the images chosen (see Anexes for larger size images).

Figure 130 : Comics / Animation wordcloud (source: researcher, 2017, www.tagcrowd.com).

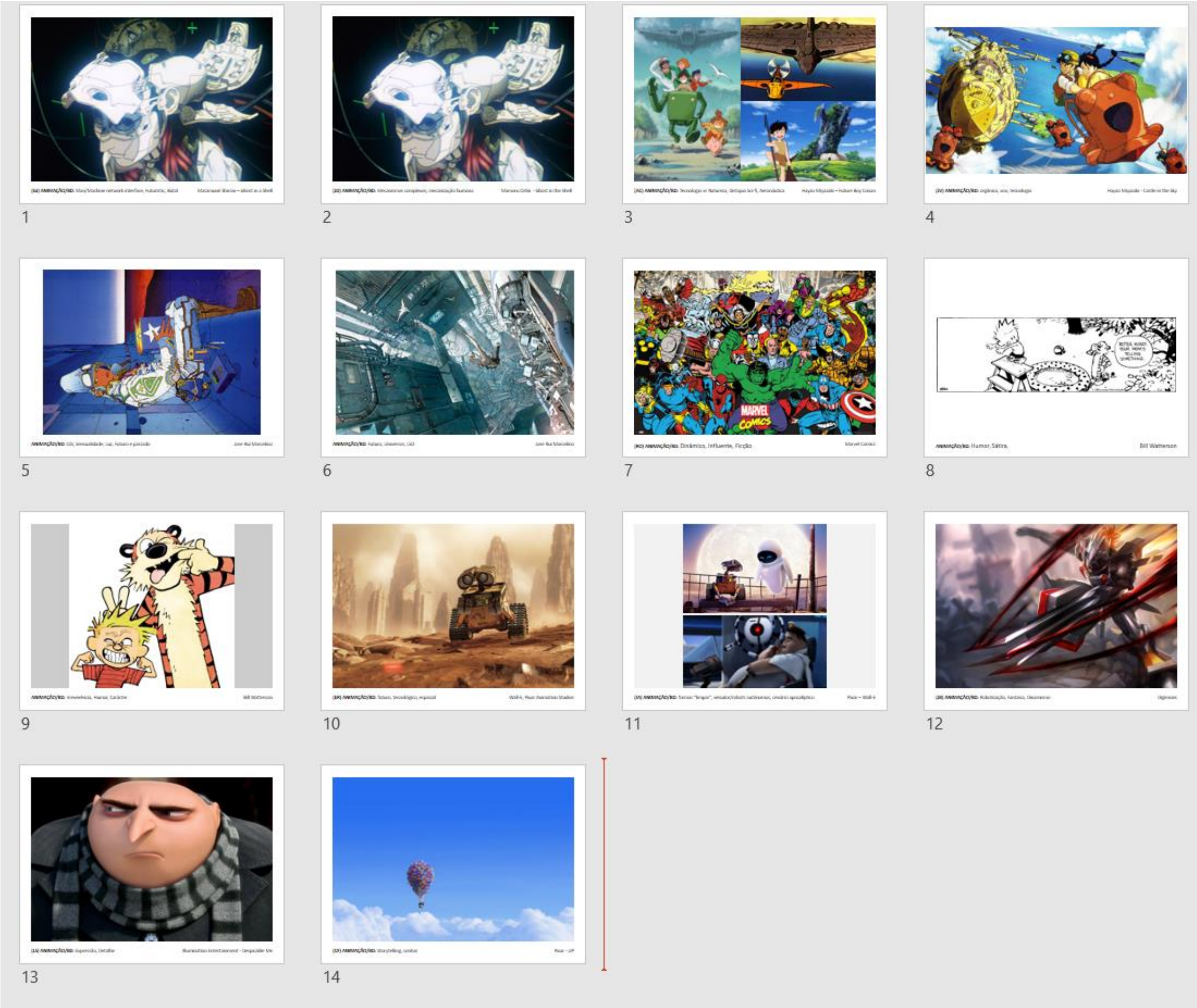


Figure 131 : 14 choices for Comics / Animation theme (source: researcher, 2017)

2.5.8 Art

Designers' choices for Art included several projects, from Sculpture, to Painting, Architecture, Movie Conceptual design, Body Art and even Dance. Although the choice is quite eclectic, three major groups can be defined:

- Sculpture (ORGANIC, COMPLEX)
- Painting (LIGHT, COLOR)
- Body Art (DETAILED)

Keywords vary with a few repetitions such as LIGHT, COLOR, COMPLEX, DETAILED, ORGANIC and WHITE. The remaining words can be tentatively grouped in the following categories:

- COLOR: light, white, warm, intense
- ORGANIC: Lightness, sensual, fluid, feminine

Figure 132 presents the Wordcloud, followed by Figure 133, which presents the images chosen (see Anexes for larger size images).

Figure 132 : Art wordcloud (source: researcher, 2017, www.tagcrowd.com).

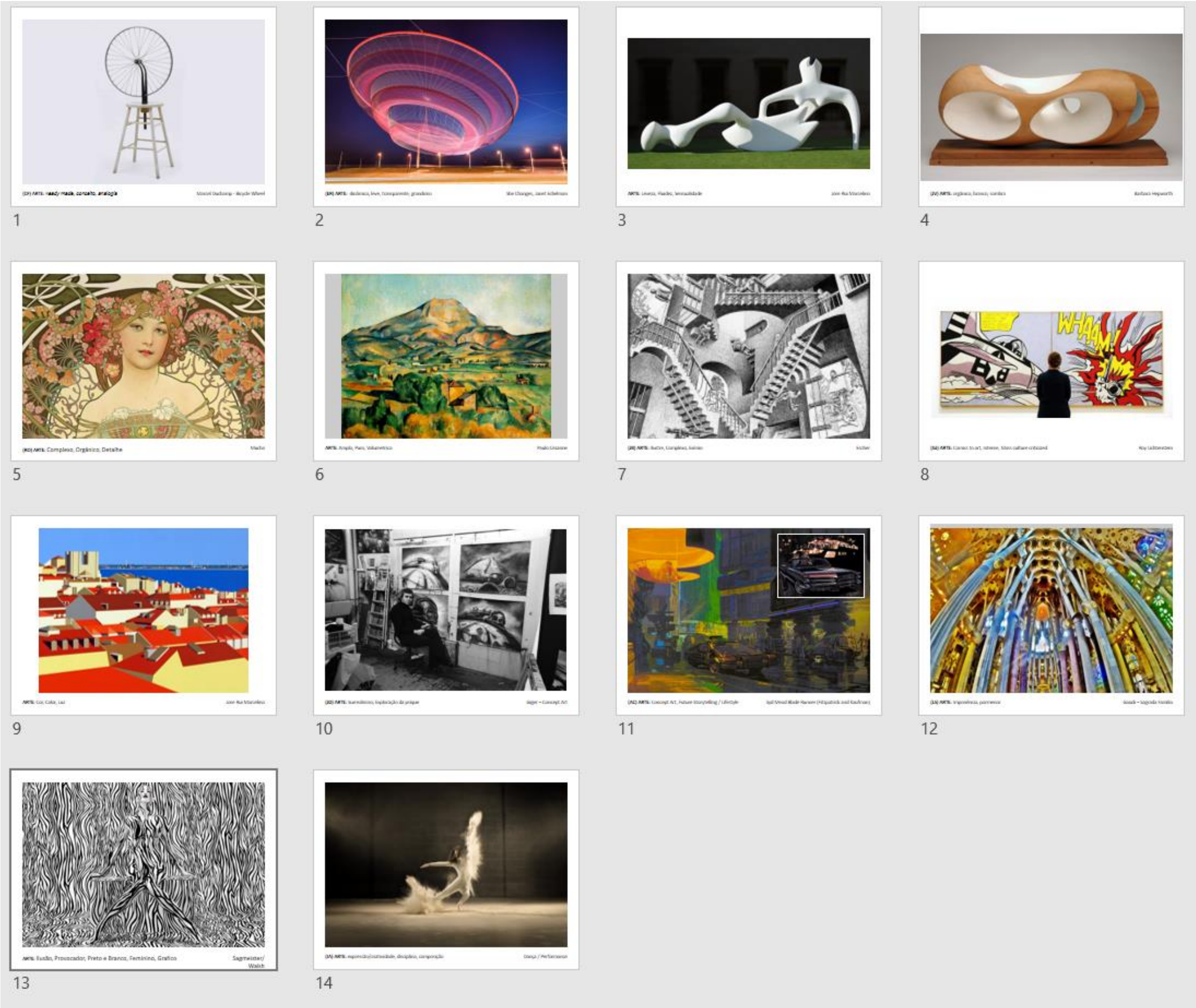


Figure 133 : 14 choices for Art theme (source: researcher, 2016)

2.5.9 Nature

Designers' choices for Nature included several references, from animal to vegetal kingdoms, ranging from process analogies to form analogies, mathematical / geometrical relations (Fibonacci sequence, Fractals, etc), etc. Although the choice is quite eclectic, three major groups can be defined:

- Mathematical relations (FRACTAL, GEOMETRY)
- Animals (NATURAL SELECTION)
- Ecosystem (EFFICENT)

Also in this case, keywords vary, with only few repetitions such as BEAUTY, EFFICENT, FRACTAL, NATURAL SELECTION, GEOMETRIC. We propose to group the words in the following categories:

- GEOMETRY: fractal, fine detail, patterned, nature code, rythmic, texture
- NATURAL SELECTION: efficient, evolutive, persistent, form follows function, elegance, lightness
- EFFICENT: structural, speed, universal aesthetic, bionic

Figure 134 presents the Wordcloud, followed by Figure 135, which presents the images chosen (see Anexes for larger size images).

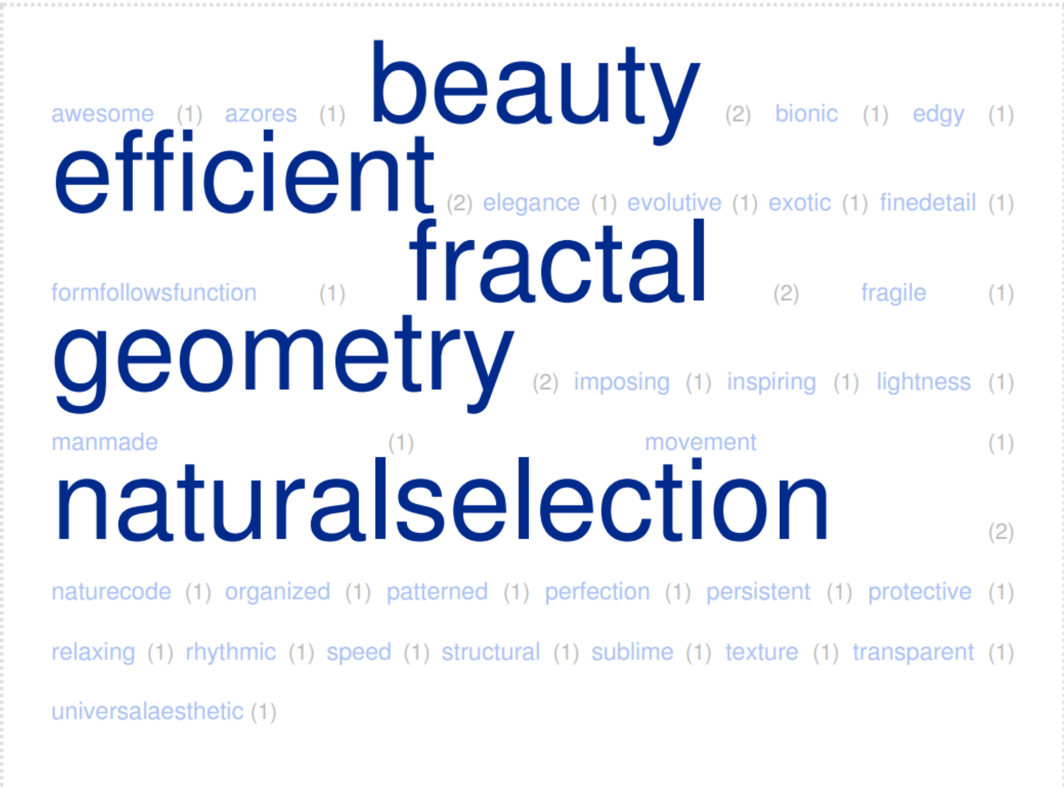


Figure 134 : Nature wordcloud (source: researcher, 2017, www.tagcrowd.com).

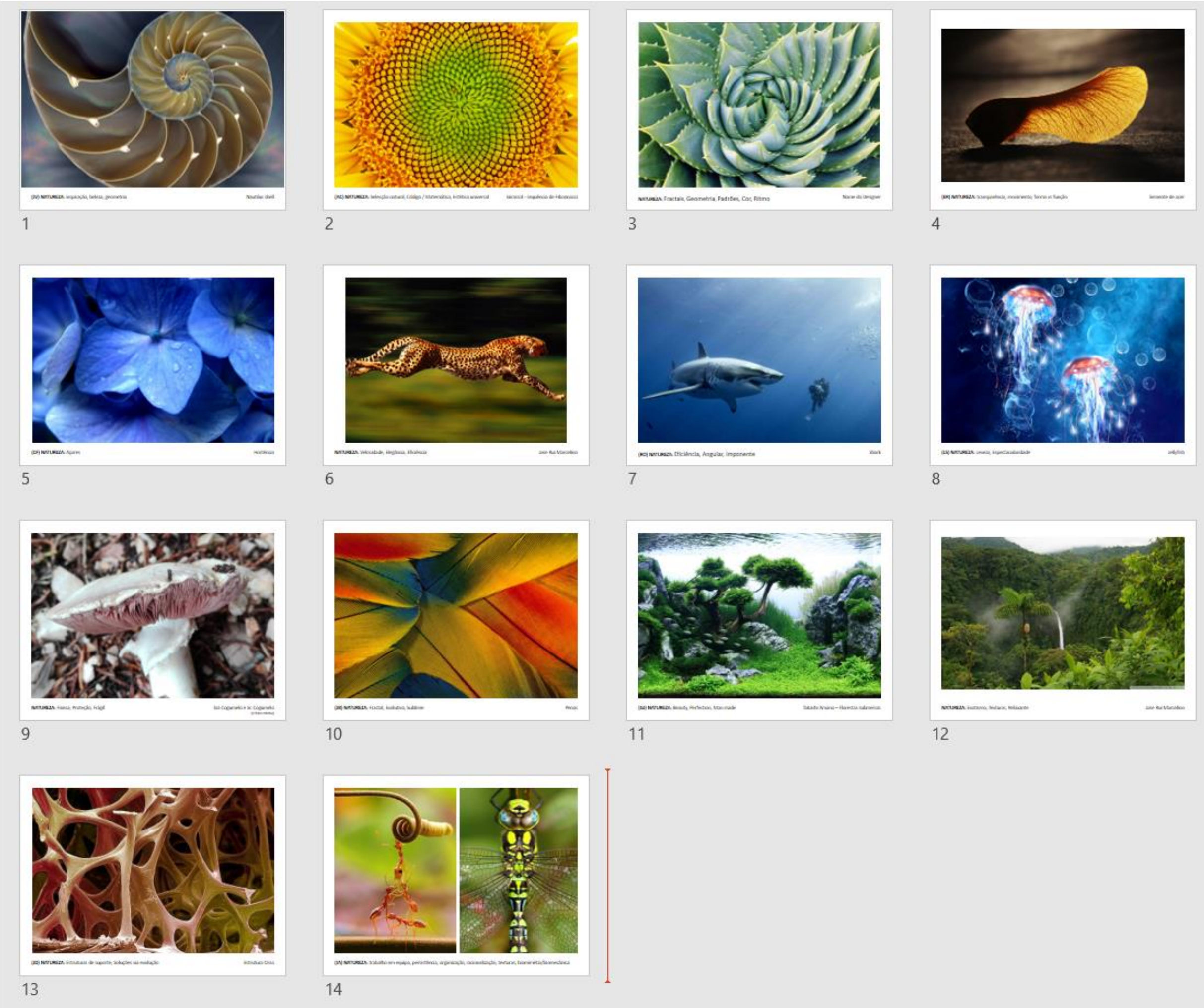


Figure 135 : 14 choices for Nature theme (source: researcher, 2016)

2.5.10 Future

Designers' choices for theme "Future" included several references, from sustainable utopias, to autonomous mobility systems to dystopian visions. Interestingly enough there are some themes which repeat themselves, three major groups can thus be defined:

- Sustainable utopia (SUSTAINABLE, TECHNOLOGICAL))
- Autonomy (EFFICIENT, AUTONOMOUS)
- Dystopia

Choice of keywords is also quite varied, with a few words repeatedly used to define the choices: SUSTAINABLE, TECHNOLOGICAL, EFFICIENT and AUTONOMOUS. We propose to group the remaining words in the following categories to obtain a clearer view of the choices:

- SUSTAINABLE: technological, bionic, blue-green, ecological, elegant, essential, harmony, humanization, self-suficient, smart-materials
- AUTONOMOUS: technological, efficient, cross-platform, generative, limitless, explorer, management, mobility, sharing, space

Figure 136 presents the Wordcloud, followed by Figure 137, which presents the images chosen (see Anexes for larger size images).

Figure 136 : Future wordcloud (source: researcher, 2017, www.tagcrowd.com).

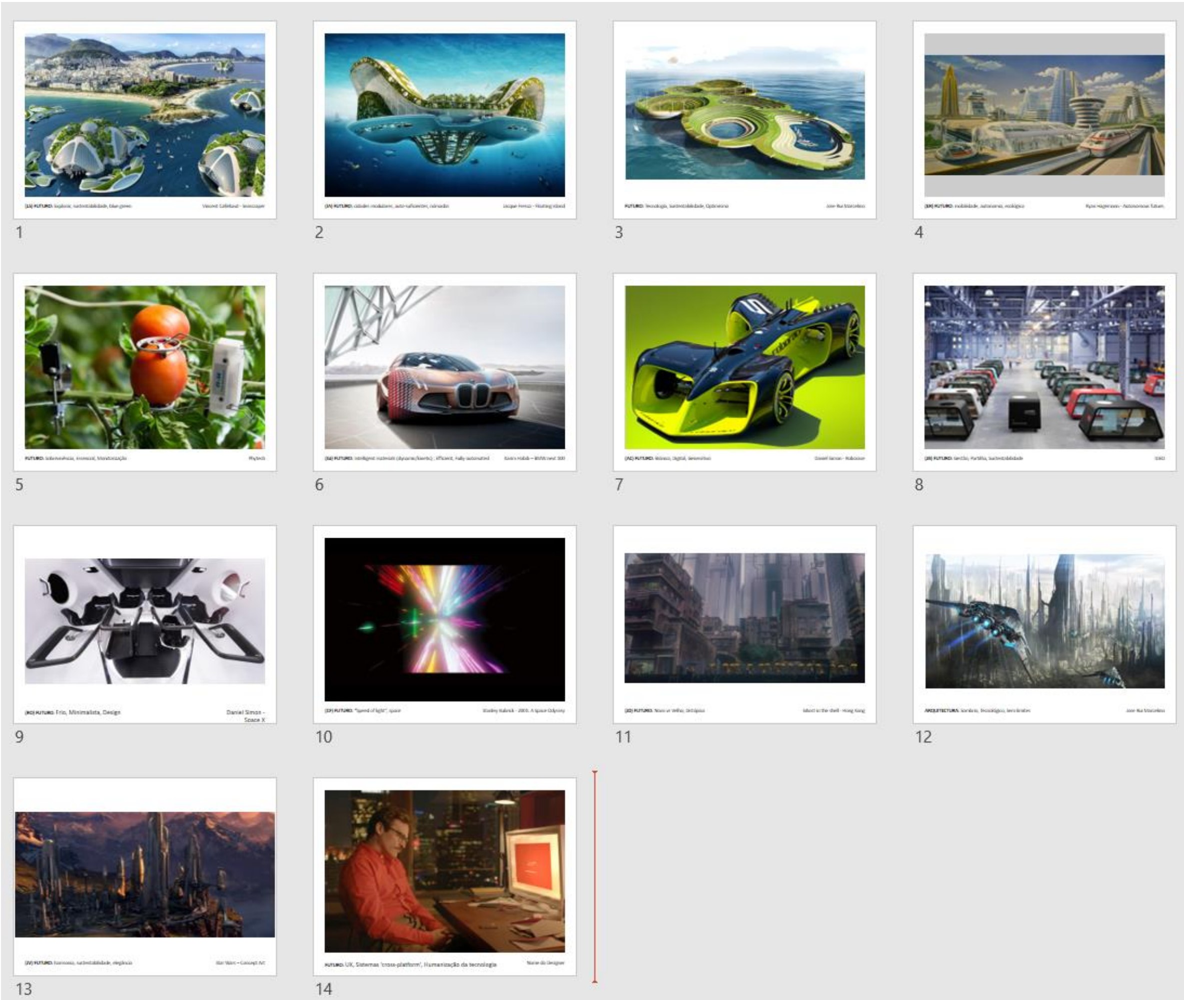


Figure 137 : 14 choices for Future theme (source: researcher, 2016)

2.5.11 All categories (top 233 words)

Considering a final overview on all themes, we can get a clear picture of the most commonly used keywords which describe the design and form language references of Almadesign current and ex-designers. Main words which appears the most are:

- ORGANIC (17)
- TECHNOLOGICAL (14)
- FUTURISTIC (11)
- MINIMAL (8)
- MATERIALS (7)
- LIGHT, FUNCTIONAL, TIMELESS, TRANSPARENT, FUNCTIONAL, DETAILED, DYNAMIC (6)

These words may well sum up the main references and themes in the culture of the studio's designers. They encompass the main references expressed and also probably the main thematic inspiration tools they use in their creative process. It is an interesting tool for the investigation and gives an impression of the current status regarding the company's visual culture. The wordcloud with the TOP 233 words is represented in the Figure 138, below:

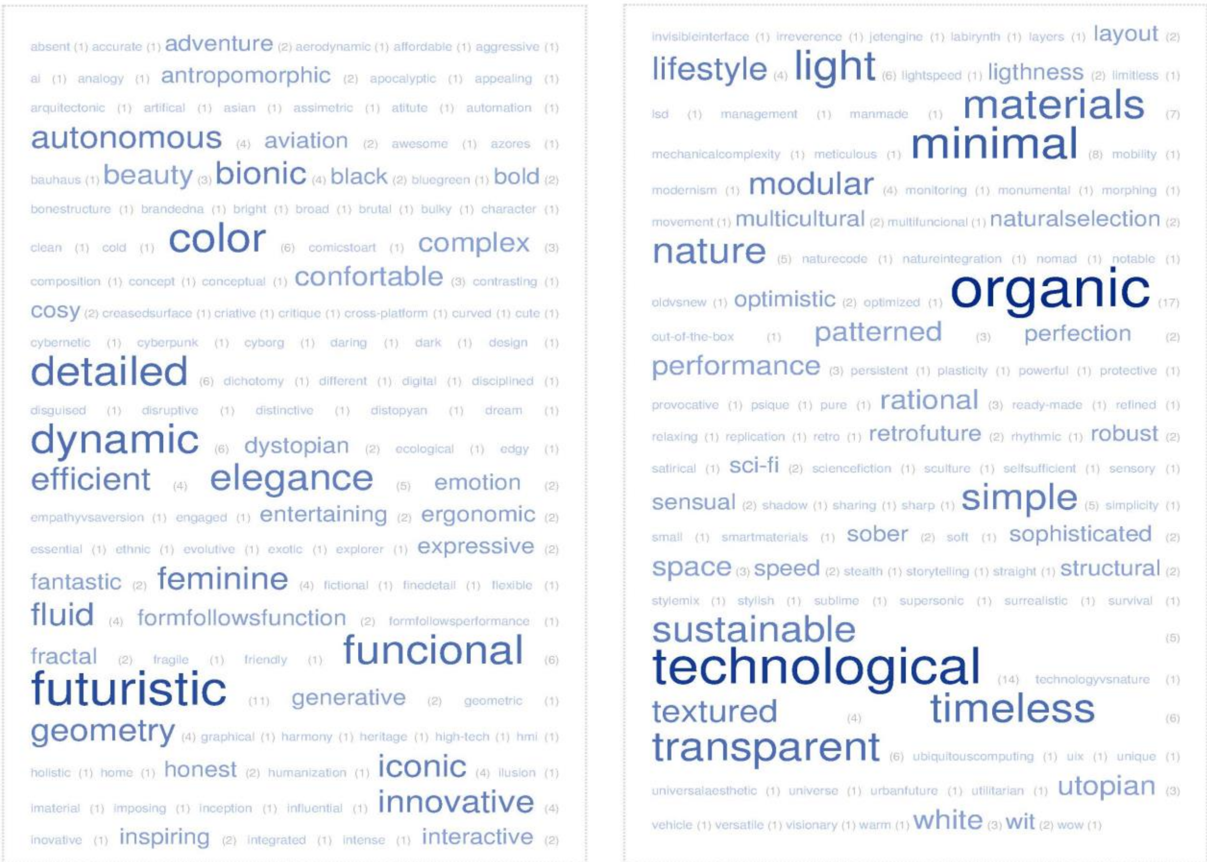


Figure 138 : "Word cloud" example developed for top 233 words used by the designers (source: researcher, 2017, www.tagcrowd.com)

2.6 ***Discussion***

This Chapter presented the work developed for Experimental Study #2: “Box of Favorite Things”. Including its Objectives, Methodology, Results and Conclusion. The following objectives were set and at least partially achieve for Experimental study #2 as explained in the following points:

- To collect a series of references which make up a “box of favorite things” for each of the studio’s current designers: this was achieved via the development of a template which was distributed and filled in by the designers with images and keywords.
- To debate the selection with the designers in order to understand their choices, their visual culture, main inspiration and references: this was achieved in the presentation and discussion session at Almadesign, together with the selection of images and keywords.
- To cross the collected information with results from Experimental study #1 and try to establish bridges (isolate constants, tendencies) between the projects’ Form Language and the designers’ visual culture and background: this was partially achieved, as many keyword references such as “Sci-Fi” and “Nature” were common between student’s choices for Almadesign projects and the designers own visual culture.

The following table 13 includes the summary of keywords selected for each theme.

Table 13 - Experimental Study #2: Summary of keywords per theme

EXPERIMENTAL STUDY #2 – SUMMARY OF KEYWORD PER THEME		
Theme	**Main keywords**	**Other keywords**
Transport	Technological	Aerodynamic, autonomous, disruptive, futuristic, high-tech, innovative, jetengine, science fiction, speed, stealth (associated with aircraft)
	Organic	Nature, fluid, bionic (associated with aircraft interiors, railway interiors and boat)
	Minimal	Timeless, sophisticated, simplicity (associated with bikes and VW van)
Automotive	Innovative	Aerodynamic, autonomous, disruptive, futuristic, high-tech, innovative, jet engine, science fiction, speed, stealth (associated with aircraft)
	Iconic	Antropomorphic, cute, simples, feminine, friendly, organic, retro, simple, simplicity, small, utilitarian
Product	Organic	Feminine, nature, bonestructure, comfortable, ergonomic (associated with aircraft)
	Functional	Minimal, timeless, honest, iconic, rational, simple, bauhaus
Fashion	Technological	Materials, performance, bionic, innovative, futuristic, dynamic
	Sober	Simple, sophisticated, stylish, timeless, distinctive
Architecture	Organic	Nature, transparent, antropomorphic, emotion, fluid, futuristic, plasticity
	Rational	Nature integration, modular, minimal, modernism
Cinema	Futuristic	Technological, artificial, space, cyberpunk, distopian, fantastical, out-of-the-box, ubiquitous computing
	Adventure	Entertaining, attitude, heritage, iconic
Comics	Futuristic	Technological, apocalyptic, automation, cyborg, dystopian, sci-fi, fantastic, technology vs nature
	Humor	Wit, satire, character, irreverence
Art	Organic	Lightness, sensual, fluid, feminine
	Color	Light, white, warm, intense
Nature	Geometry	fractal, fine detail, patterned, nature code, rythmic, texture
	Natural selection	efficient, evolutive, persistent, form follows function, elegance, lightness
	Efficient	structural, speed, universal aesthetic, bionic
Future	Sustainable	technological, bionic, blue-green, ecological, elegant, essential, harmony, humanization, self-suficient, smart-materials
	Autonomous	technological, efficient, cross-platform, generative, limitless, explorer, management, mobility, sharing, space
Most frequent Words	Organic (17) - Technological (14) - Futuristic (11)	

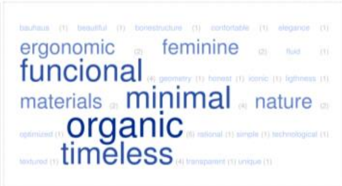
(source: researcher, 2017)

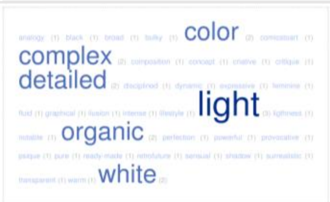
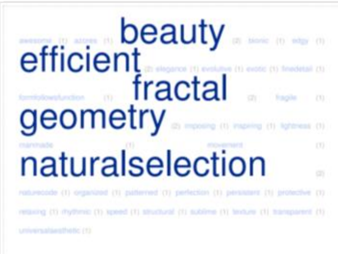
This preliminary approach to the discussion of the study, both Quantitative and Qualitative, together with the Discussion during the Almadesign Experimental study #2 session can be summarized as the preliminary discussion in the following points described below:

- Designers differ in age groups, work experience at Almadesign, gender, etc. but show a lot of common trends;
- Results show common trends between designers, with several choices repeated as well as keywords to describe the choices;
- Transport design choices feature speed metaphors, “nature” inspired design and technology overstated by design;
- Automotive design choices feature sensual and large proportions, emotive and aggressive surfacing; on the other hand, automotive design choices also feature friendly designs, with small dimensions “cute” effect faces and expressions;
- Architecture references tend to be highly formalist, iconic, dynamic and nature inspired;
- Product design choices tend towards a more conservative approach, specifically a technological minimalistic style on electronic products; furniture tends to be more emotional and organic / nature inspired;
- Cinema references focus predominantly in Sci-fi movies, featuring iconic designs, bright elegant speed metaphors or on the other hand dark and dystopian views;
- Trends for future design focus on dialectics between nature and technology, human and machine, from engineered sustainable choices to automated, generative designs using smart materials and technologies;
- Words which are more frequently used include: Futuristic, Organic, Technological, Functional, Minimal, Transparent, Timeless, Detailed, Dynamic, etcetera; these words will be used further on to support the development of the Survey – Experimental Study #3, for Almadesign clients and partners.

It is considered that the objectives of this chapter were generally achieved. More data analysis is needed to reach other conclusions and integrate the information with the Case Studies, with the objective of understanding if there is a specific Visual Culture in Almadesign, how it translates into a specific Form language and how this language is interpreted by clients and partners. Some preliminary conclusions on the Study #1 and #2 were the following: there is a close correlation between specific Almadesign projects and references to Sci-Fi, Nature and Technology themes. These correlations are much higher than on any of the other selected projects from competitor consultancies. Studio designers also refer these keywords to characterize their own Visual Culture. This underlines a certain validity in the hypothesis, that we can identify a specific Form Language development, and it is influenced by a visual culture with roots on “Technological”, ”Sci-Fi” and “Nature” themes, portraying a specific (optimistic) vision of the future and of the relation between user and technology. The following Table 14 sums up the main findings.

Table 14 - Experimental Study #2: Summary of data gathered

EXPERIMENTAL STUDY #2: SUMMARY OF RESULTS			
Categories	**Word cloud**	**groups**	**Examples**
Transport Design		High performance aircraft (TECHNOLOGICAL) Transport interiors (ORGANIC) Bicycles and motorbikes (MINIMAL)	  
Automotive design		High performance cars (INNOVATIVE) "Cute" (ICONIC)	 
Product design		Chairs (ORGANIC) Electrical appliances (MINIMAL)	 
Fashion Design		Shoes (and sports clothing) (MATERIALS) Sci-fi costume design (TECHNOLOGICAL) Haute couture (SOBER)	  
Architecture		Nature inspired (antopomorphic and parametric form languages) (ORGANIC) Modernism (modular approach	 

		and nature integration (MODULAR)	
Cinema / Movies		SCI-FI in space (FUTURISTIC) SCI-FI in earth ACTION MOVIE (ADVENTURE)	   7
Comics / Animation		Japanese Anime (AUTOMATION) Franco-belge Comics (FUTURISTIC, APOCALYPTIC) Animation movies and Comics (FUTURISTIC, HUMOR)	  
Art		Sculpture (ORGANIC, COMPLEX) Painting (LIGHT, COLOR)	 
Nature		Mathematical relations (FRACTAL, GEOMETRY) Animals (NATURAL SELECTION) Ecosystem (EFFICENT)	  

(source: researcher, 2017)

3 EXPERIMENTAL STUDY #3: Visual language of Almadesign

3.1 *Introduction*

Experimental study #3 was named "Visual Language of Almadesign" and was developed with the main objectives to engage Almadesign clients / partners in the investigation and collecting a series of perceived Semantic references in three of the studio's projects, also used as Case Studies. A survey was developed in the context of the investigation, with the aim to establish which Semantic attributes are perceived by clients / partners through a series of multiple choice questions and one open question. In doing so, the investigation is trying to establish bridges - isolate constants, tendencies - between the projects form (visual) language as interpreted by clients / partners.

3.2 *Objectives*

The following objectives were set for Experimental study #3:

- Develop an on-line survey for Almadesign clients / partners;
- Collect data on the way the studio's Form (visual) Language is perceived and interpreted by clients / partners;
- Establish bridges – isolates constants, tendencies – between the project's Form Language and the perceived semantics.

Being the third of the empirical studies developed with a set of users, in this specific case, clients / partners, it was fundamental for the investigation to gather information about how these stakeholders, some of whom have been working with Almadesign for several years, perceive and interpret the semantics of the studio's Form Language. Nevertheless, it is important to note that these stakeholders are not the final users of the studio's design. In the three projects used for the online survey, Project Winner was developed for a client, Caetanobus, which is an OEM. This means Caetanobus sells its products to bus and coach fleet operator which then provides transport services to final users (passengers). In the case of project inTRAIN and LIFE, the studio worked with partners due to the nature of the projects, which were R&D EU funded projects. There were no final users testing the prototypes in a real environment, but only as demonstrators. Experimental study #3 should provide data about how clients and partners perceive the studio's Form Language, but not as final users (passengers) perceive it. This is considered out of the scope of the current investigation.

3.3 *Methodology*

3.3.1 Dates, participants and sample size

Experimental study #3 was developed in the period from the March 2017 to June 2017. During this period, several tasks were tackled in the investigation such as Planning Activities, Literature Review and Empirical Investigation activities. The Experimental study was prepared by the research team and implemented during the month of May and June 2017 as a qualitative study with Almadesign clients / partners with the objective to gather data on the Semantics of the studio's Form Language.. The Survey comprised 50 questions and was sent to 20 of the Studios most experienced clients / partners. The researcher could gather 16 validated responses.

3.3.2 Evaluation approach

The Experimental study was conducted through an online survey. The following chart summarizes the evaluation approach developed by the researcher:

Table 15 - Experimental Study #3: Data collection methodology

EXPERIMENTAL STUDY #3 - "THE VISUAL LANGUAGE OF ALMADESIGN" – DATA COLLECTION METHODOLOGY					
Type of study	**What needs to be measured**	**Data to be collected and collection method**	**Access issues / Tools**	**Timeline / Venue**	**What was done**
Qualitative study with design clients / partners conducted with an online Survey	Semantic references related to 3 specific Almadesign projects, as interpreted by final users (clients / partners)	Survey results (multiple choice questions, open question; Online survey with 50 multiple choice questions and 1 open question	Preparation of the Survey, availability of clients / partners	March – June 2017; online	Experimental study was prepared via a selection of images of the 3 Case Study projects and a set of about 15 multiple choice questions for each one. The survey was prepared with an online software and tested in Experimental study version with designers. A final version was checked with the orientation team and sent to a list of 20 of the most experienced Clients / Partners. In the end of June, 17 complete surveys were collected. Information was visualized using pie graphics.

(source: researcher, 2017)

3.3.3 Procedure

Study #3 was developed using an online survey software tool (google forms). A questionnaire was developed starting by a short introduction and interviewee information questions to help define the respondent profile. For each of the three selected projects a specific section with a title and three images was developed, associated with five sets of questions each. In total, fifteen “double choice” questions were asked per project (total of forty-five “project related” questions). Towards the end of the survey, another general question appears in order to filter respondents’ type of collaboration and make a specific question tailored for each group. Finally, an open question, with a more creative feel was used in the end of the survey, in an attempt to finish in an “upbeat”. Most of the questions were closed-ended in order to make them more suitable to answer quickly, considering a lot of the respondents are managers and / or CEOs of companies, the time considered for the survey should be as short as possible. Question order was carefully tailored to provide a smooth flow of questions, and the double choice was always based on two “positive” adjectives concerning the project. The order of the adjectives was randomized in the last project, in an attempt to avoid bias due to the repetition of the questions.

Questions were developed to measure specific concepts through the association with keywords. The objective was to use keywords which would be clear to the interviewees regarding the questions and its meaning, although some of the keywords might have been interpreted in different ways (this is further analyzed in the discussion section). Technical terms and jargon was avoided, there was an effort to keep the words clear and easy to understand. Double-barreled questions were avoided.

The questionnaire was developed in a “pilot” version which was tested several times with 5 different respondents (3 designers and the orientation team). Updates and changes were made before developing the final version. In the questionnaire design, some recommendations were followed regarding the design, based on the Harvard University program on survey research. The following points were considered:

> *Keep Your Questionnaire Short (…) Respondents are less likely to answer a long questionnaire than a short one, and often pay less attention to questionnaires which seem long, monotonous, or boring. Keep Question Order in Mind: Survey responses can be impacted by previous questions. Start a questionnaire with an introduction. If a respondent reads the survey, provide a title for each section. It’s usually best to start a survey with general questions that will be easy for a respondent to answer (…) If you are asking a series of similar questions, randomizing the order respondents hear (read) them can improve your data. Respondents should only be asked questions that apply to them. Open-ended questions allow the greatest variety of responses, but are time consuming to ask and require a lot of work to analyse. Closed ended questions, when well designed, ensure that respondents interpret questions. Respondents are more likely to skip an open-ended than closed-ended question (…) The ideal question accomplishes three goals: It measures the underlying concept it is intended to tap; It doesn’t measure other concepts; It means the same thing to all respondents (…) Avoid technical terms and jargon. Words used in surveys should be easily understood by anyone taking the survey. (source: charrison@gov.harvard.edu, Acessed: Nov.2017)*

With the objective of analyzing the Form Semantics of the three projects, nine images and a set of fifteen adjectives per project and their antonyms were chosen. Based on the identification of keywords used by designers in both Experimental study #1 and Experimental study #2, the fifteen adjectives and respective antonyms (some more “literal” than others) were chosen. The strategy devised by the research team was to choose adjectives “free of value judgement”, that would allow clients / partners to always choose the most appropriate keyword.

The fifteen pairs of adjectives were grouped (five for each image shown) and respondents were asked to choose the ones they thought represented the most important features of Almadesign Form Language. The choice between two pairs of antagonistic adjectives resulted in clear choices, which helped to achieve clear results, albeit less detailed ones. One could argue that a scale between the two would have been more appropriate, but from the initial pilot testing of the survey it was found that respondents found it much quicker and easier to choose one of the words and thus identify the most important features (and not scale them). Nevertheless, in the beginning of the survey, a “mood” alert was triggered by means of a short sentence explaining the case of having to choose just one adjective, and not having to scale it: “we don’t think the world is in black and white, but we ask you to choose only one of the adjectives”. Some general questions about each respondent were devised to filter information on years of practice, knowledge about the projects, etcetera.

A final “open” question was devised, in which the respondents were asked to name a particular automotive Brand which they would associate with Almadesign and explain why. This enabled the respondents to go a little bit deeper in the analysis, after making their choice of adjectives, and by means of association with a familiar theme (car brands) associate some intangible questions to Almadesign Form Language.

The survey was directed specifically at industry experts, with ten to more than twenty five years of experience in their industries (top level engineers, marketers, managers, etcetera) enabling a very focused research with some of the most important clients and partners, which have commissioned and supported Almadesign work. Due to the nationality of the partners and clients chosen, the survey was developed in Portuguese and later translated to English. The twenty interviewees were chosen from the company’s client and partner database and with the agreement of the studio’s top management. The following criteria were developed for the choice of participants:

- Participation in projects with Almadesign (as a client and / or partner) and therefore familiarity with the company’s work and Form Language;
- "Seniority" of the people involved (experts with several years of experience in the industry, from ten to more than twenty-five);
- Different professional areas: engineering, marketing, design, management, etc.;
- Gender: an effort was made to balance the number of women and men chosen for the survey, in an attempt not to bias the results;
- Approval from Almadesign top management.

A specific, personalized e-mail was sent to each of the participants asking for her / his participation participate in the survey. A 4-week period was given to the clients / partners, after which another e-mail was sent, in order to gather more responses. The questionnaire was developed in Portuguese and sent to Portuguese speaking clients / partners only. The following image shows the survey design as it was developed by the researcher with five initial questions for Project Winner Facelift (Figure 139). The complete questionnaire can be accessed in the Annexes.

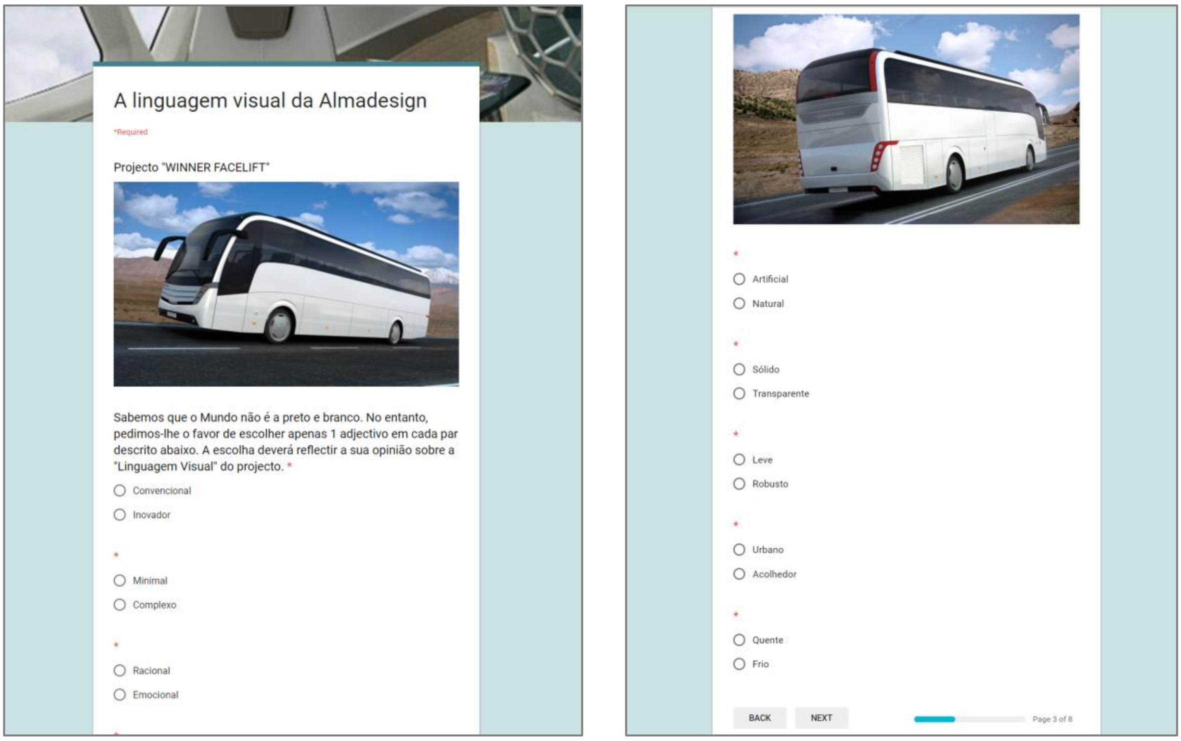


Figure 139 : Experimental Study #3: On-line survey template (source: researcher, 2017)

3.4 *Data collection*

The final version was prepared and sent via e-mail to each of the 20 participants. In total 16 complete responses were received and validate by the researcher. The following information was gathered:

- 16 completed responses;
- Each questionnaire response includes: 7 general information answers; 35 answers; 1 open-ended answer concerning Almadesign studio;
- 240 adjectives selected for each project;
- 720 adjectives selected in total.

A spreadsheet with the results was developed with the total 16 completed surveys (see Appendix 3). A strategy for analysis was devised, as shown in Table 16:

Table 16 - Experimental Study #3: Data collection and analysis

EXPERIMENTAL STUDY #3 - DATA COLLECTION AND ANALYSIS		
Data gathered	**Quantitative analysis #1**	**Quantitative analysis #2**
16 completed surveys; 240 adjectives per project;740 adjectives, 16 open-ended answers;	Pie chart graphical representation for each answer; short paragraph with explanation	Open-ended answers are shown and analysed

(source: researcher, 2017)

- Data analysis #1: Pie chart graphics for each answer and each project are shown; a short paragraph with the main conclusions is developed, trying to establish connections between similar answers, trends, tendencies, consistencies, etc.
- Data analysis #2: open-ended answers (16 in total) are compared and analysed by the researcher in order to find trends and tendencies;

3.5 *Results*

The following graphics and text present the results and provide some explanation for each of the answers. Starting with the general information questions, the figures below show the results. The first question (which identifies the company of the respondent) is not referenced due to the confidentiality of the information.

3.5.1 General information questions

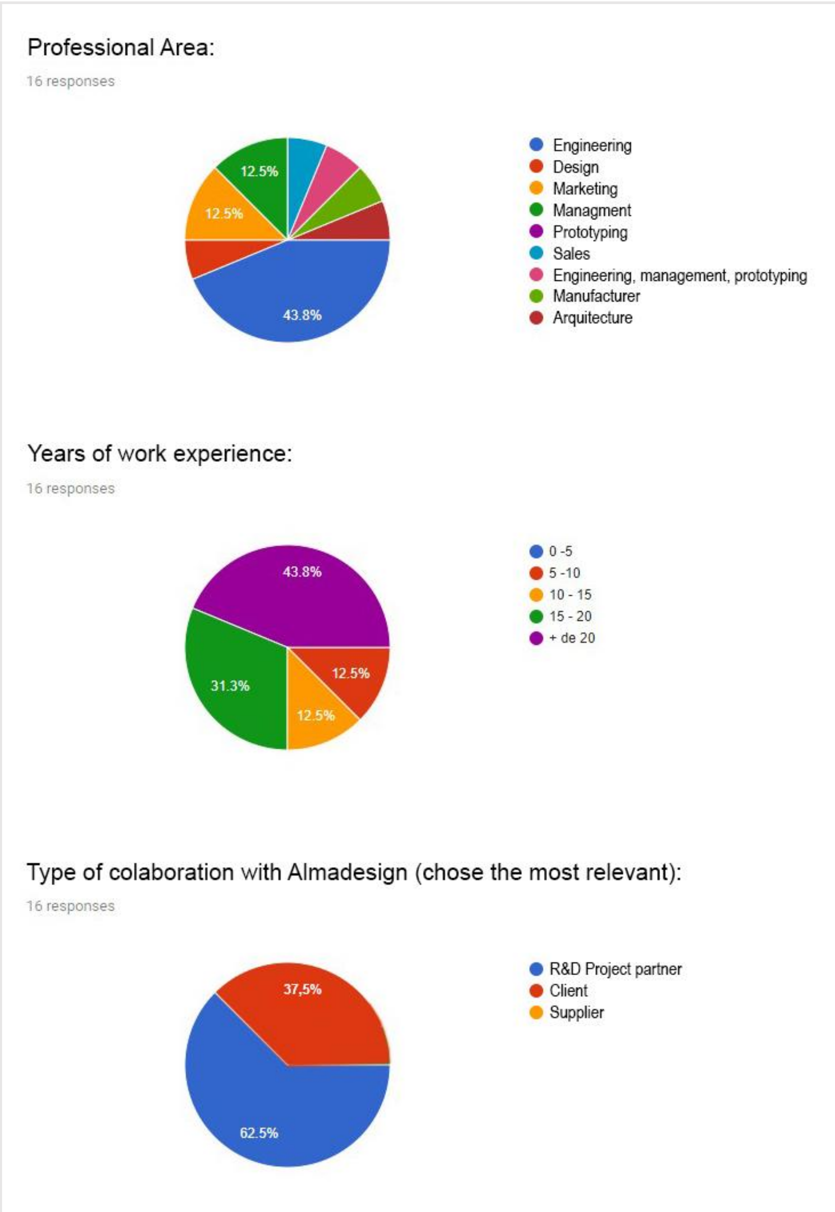


Figure 140 : Pie-chart graphics with general information questions (source: researcher, 2017)

In terms of the professional area of the respondents 43,8% are from the engineering area. In fact, if the category of engineering / prototyping and the manufacturing is added, we end up with more than 50%. This is quite interesting as it shows 2 things: first, Engineers are by far the most important interlocutors of clients towards Almadesign work. Which means the area of specialization of the company is very technical and designers at Almadesign have to be able to communicate with engineers and engineering departments. The studio itself was founded by a design / engineer, which also accounts for this trend. On another view, we can also argue that most companies in Portugal are technically managed by engineers, which is still the main profession to address important jobs in the industry. Nevertheless, 12,5 % of the respondents are from Management and Marketing positions in the companies. In terms of experience, all the respondents have more than 5 years of experience, with 31,3% having between 15-20 years of experience and 43,8% with more than 20 years of experience. In terms of the type of collaboration with Almadesign, about 60% are partners in projects and 40% are clients. In this brief outlook, we can see that partners and clients who responded to the survey are in their majority very experienced engineers and managers.

3.5.2 Project Caetanobus Winner Facelift

Below we can see the images used during Experimental study #3 for the first set of multiple choice questions. Project Caetanobus Winner Facelift was used as the starting point. Next to the images we can find the results of the Survey in simple Pie graphics, for each of the 5 questions addressed in each part of the survey (Figure 141, 142, 143):

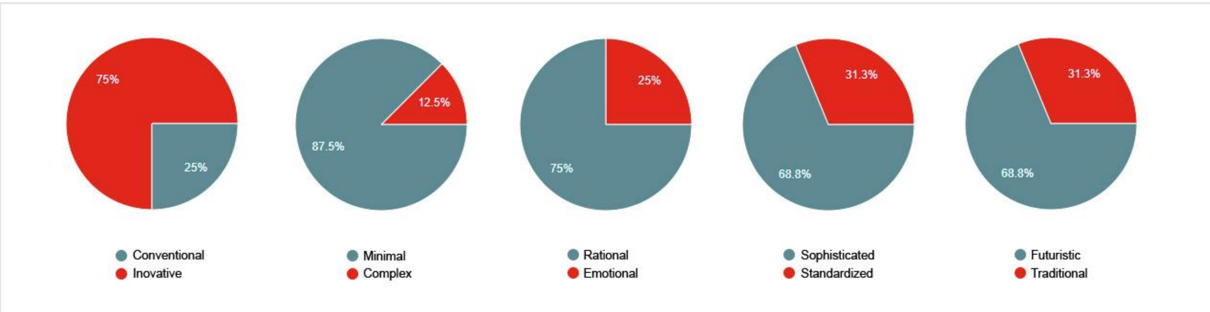


Figure 141 : Pie-chart graphics with first 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign’s Project Winner Facelift is considered by most of the participants as being Minimal (87,5%), Innovative (75%), Rational (75%), Sophisticated (68,8%) and Futuristic (68,8%).

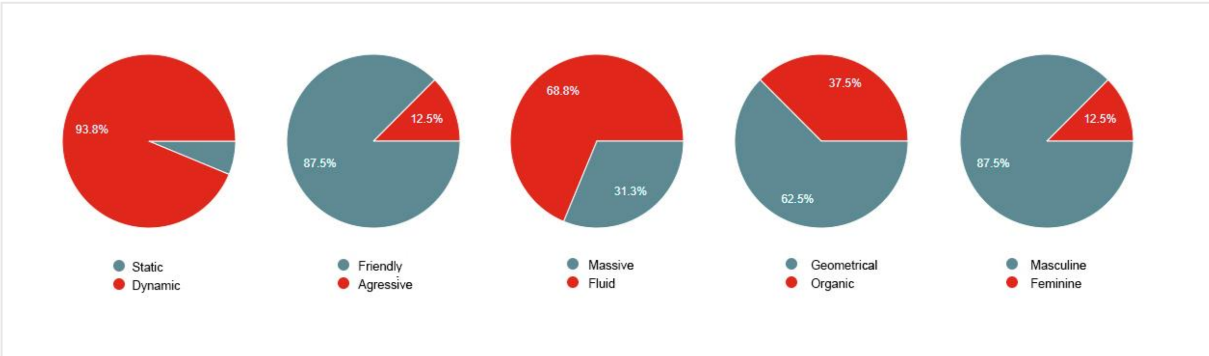


Figure 142 : Pie-chart graphics with second set of 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's Project Winner Facelift is also considered Dynamic (93,8%), Friendly (87,8%), Masculine (87,5%), Fluid (68,8%) and Geometric (62,5%).

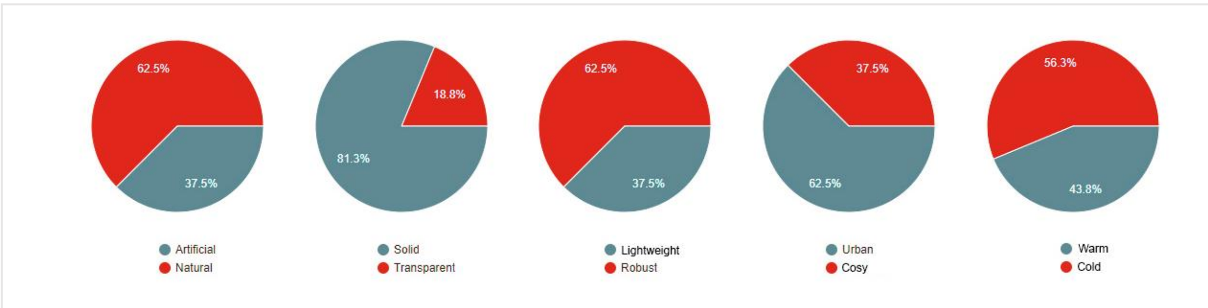


Figure 143 : Pie-chart graphics with the final 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's Project Winner Facelift is also considered Solid (81,3%), Artificial (62,5%), Robust (62,5%), Urban (62,5%) and Cold (56,3%).

3.5.3 Project inTRAIN

Below we can see the images used during Experimental study#3 for the first set of multiple choice questions. Project inTRAIN was used as the second case study. Next to the images we can find the results of the Survey in Pie graphics, for each of the 5 questions addressed in each part of the survey (Figure 144-146):

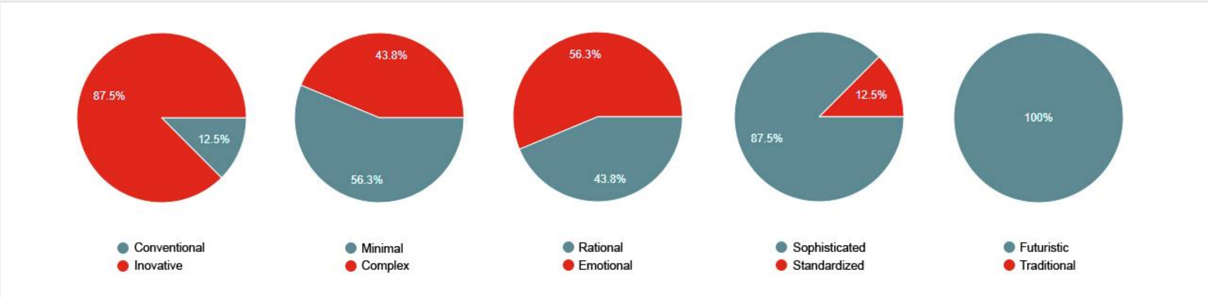
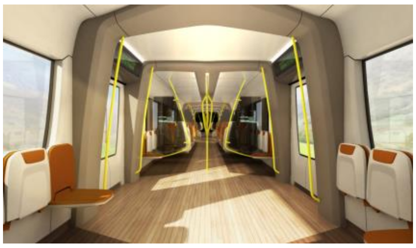


Figure 144: Pie-chart graphics with the first set of 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's Project inTRAIN is considered, clearly by most of the participants as being Futuristic (100%), Innovative (87,5%), Sophisticated (87,5%), Dynamic (81,3%), and opinions were more divided in adjectives Minimal (56,3%), Emotional (56,3%).



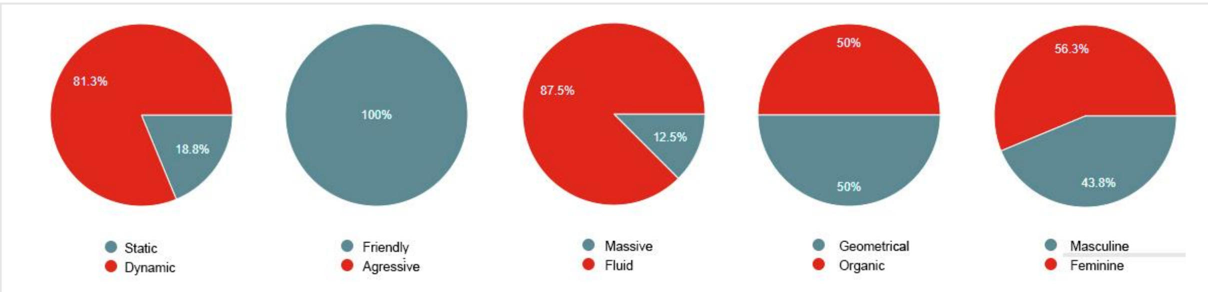


Figure 145 : Pie-chart graphics with second set of 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's Project inTRAIN is also considered Friendly (100%), Fluid (87,5%), Organic and Geometric (50% each), Feminine (56%), Natural (93,8%).

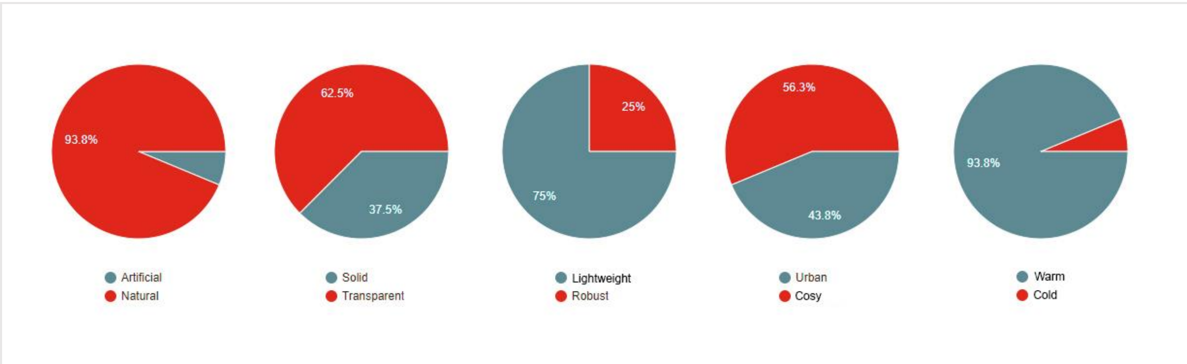


Figure 146 : Pie-chart graphics with the final 5 questions and results (source: researcher, 2017)

Results show that the Form Language in inTRAIN is also considered Natural (93,8%), Warm (93,8%), Lightweight (75%), Transparent (62,5%) and Urban (56,3%).

3.5.4 Project LIFE

Below we can see the images used during Experimental study #3 for the first set of multiple choice questions. Project LIFE was used as the third case study. Next to the images we can find the results of the Survey in simple Pie graphics, for each of the 5 questions addressed in each part of the survey (Figures 147-149):

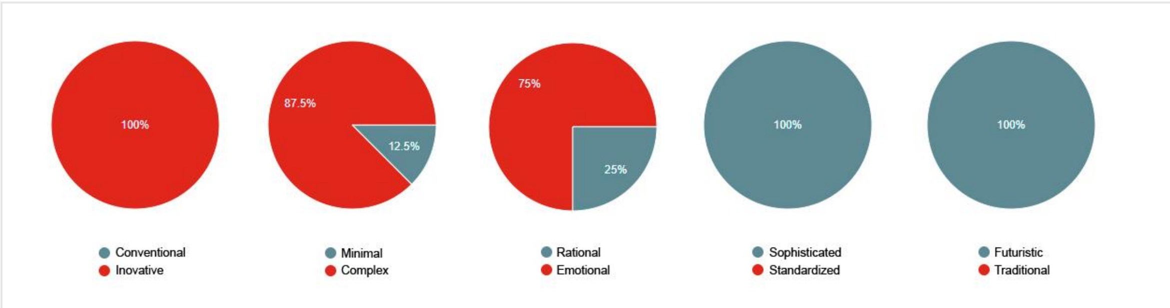


Figure 147 : Pie-chart graphics with the first set of 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's Project LIFE is considered, clearly by most of the participants as being Innovative (100%), Sophisticated (100%), Futuristic (100%), Complex (87,5%), and Emotional (75%).

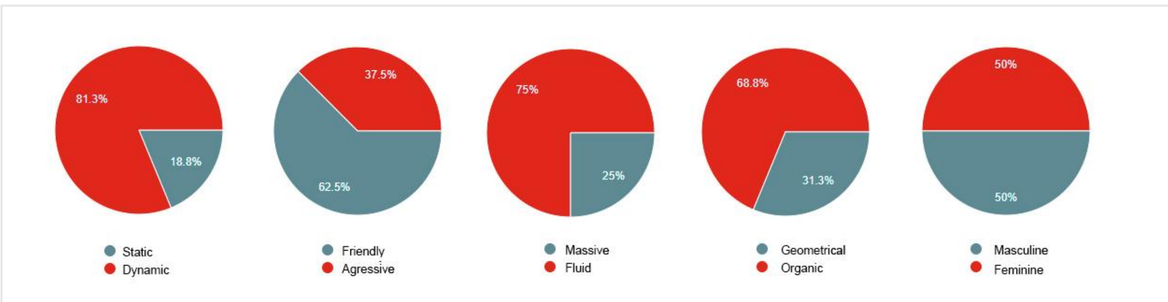


Figure 148 : Pie-chart graphics with second set of 5 questions and results (source: researcher, 2017)

Results show that the Form Language in Almadesign's LIFE is also Lightweight (87,5%), Dynamic (81,3%), Fluid (75%), Organic (68,8%) and Friendly (62,5%).

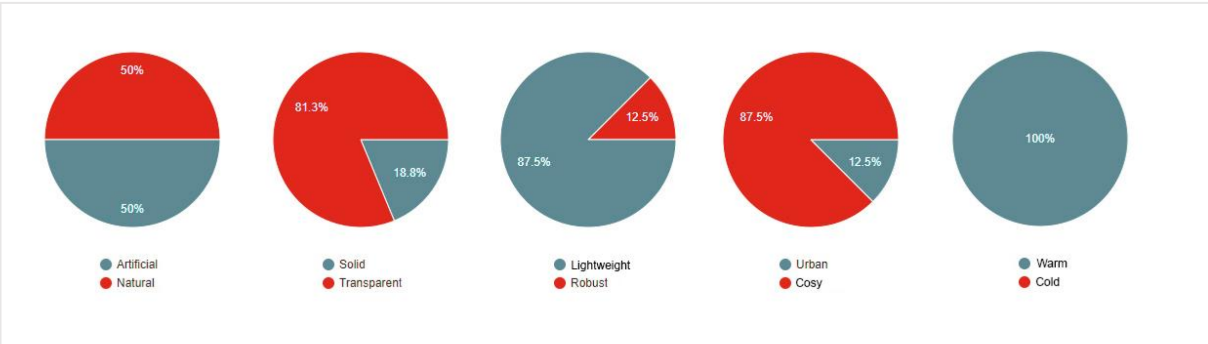


Figure 149 : Pie-chart graphics with second set of 5 questions and results (source: researcher, 2017)

Finally, results show that the Form Language in LIFE is also considered Natural/Artificial (50/50%), Transparent (81,3%), Cozy (87,5%), Warm (100%), Masculine/Feminine (50/50%).

3.5.5 Specific information questions

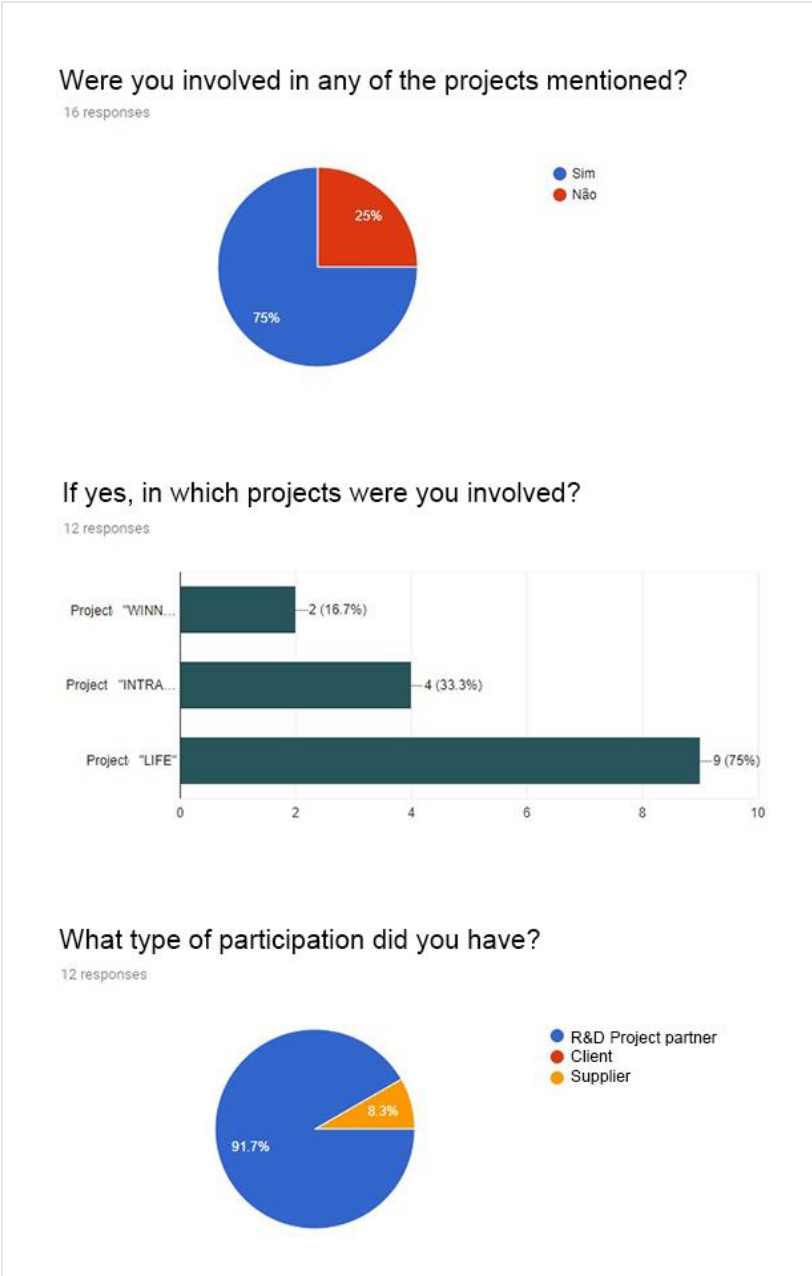


Figure 150 : Pie-chart graphics with general information questions (source: researcher, 2017)

In terms of the participation of the respondents in the projects used as examples in the Experimental study Study, 75% of respondents had participated in at least one of the projects. Project LIFE was the one most of the respondents had participated (9 out of 16), followed by INTRAIN project (4 out of 16) and Winner (2 out of 16). Mainly the role of the respondents was as partners, but also as suppliers.

3.5.6 "What if Almadesign was an automotive brand?"

Finally, one last question was formulated, in which it asked the participants to name an Automotive Brand which they would consider to be most comparable to Almadesign Studio. This was an exercise in analogy, and the automotive industry was used as an example due to the large number of technical respondents (mostly engineers, marketers and designers), which were found to have the technical and commercial knowledge about the industry. Table 17 sums up the results.

Table 17 – Answers to the question: "if Almadesign was an automotive brand…" [10]

"WHAT IF ALMADESIGN AS AN AUTOMOTIVE BRAND?"	
BRANDS	**JUSTIFICATION**
An innovative brand	"The Almadesign projects indicate this."
Citroen	"There is freedom, lightness and originality in concepts."
BMW	"The form language is similar."
Sports Vehicle brand	"That is their design trend."
Ferrari	"Because Almadesign is a machine creating visionary projects for all"
Alfa Romeu	"Because it is a design focused company just like automotive company Alfa Romeu."
AUDI	"Perceived quality above average, bold design but fully functional, deliver as expected"
Mini Cooper	"Sophisticated with some emotion"
Alfa Romeu	"Brand associated with robust lines and innovative aspects like dynamism".
Range Rover/Evoque	"Innovative design. Very Convincing. Practical and robust. Creates new lines that inspire change."
Lamborghini	"Design, Shape, Future"
Alfa Romeo	"Innovative Design."
DS (Citroen)	"The classic associated with the sophisticated."
Volvo	"Simplicity of Form / Sobriety / Rigor Design / Dynamics / Natural Materials."
Alfa Romeo	"For the creativity and design."

(source: researcher, 2017)

[10] This authors translation from Portuguese

3.6 ***Discussion***

The Experimental study #3 was prepared by the research team and implemented via an online Survey to clients and partners, in the Summer of 2017. Experimental study #3 was a qualitative study with engineers, managers and marketing experts, and the objectives were to collect information about the Semantics of Almadesign Form language, the way the design is perceived and interpreted by clients and partners. The main objective is to characterize the way the Form Language is semantically interpreted by clients / partners and establish bridges, isolate constants and tendencies which can help define the studio's Form Language. The preliminary results in the qualitative analysis are presented below. From a universe of respondents from the following areas of expertise: Engineering; Design; Marketing; Management; Prototyping; Sales; Manufacturer, 90% above the 10 years' experience (45% over 25), 60% partners of Almadesign and 40% clients, the results are shown in Table 18, for each project. The following objectives were set for Experimental study #3:

- Develop an on-line survey for Almadesign clients / partners: this was developed and 16 completed surveys were gathered;
- Collect data on the way the studio's visual (form) language in perceived and interpreted by clients / partners: this objective was fulfilled as the researcher collected more than 250 answers, gathering 720 adjectives which indicate how the Form Language is perceived.
- Establish bridges – isolates constants, tendencies – between the project's Form Language and perceived semantics: this conection will be further developed in the next chapter, with the conclusions.

The following tables 18 and 19 sum up the main findings.

Table 18 - Experimental Study #3: Summary of adjectives chosen by clients / partners

<table>
<tr><th colspan="5">EXPERIMENTAL STUDY #3 – SUMMARY OF ADJECTIVES</th></tr>
<tr><th>PROJECT</th><th>WHAT PROJECT IS DEFINITELY!
(85% - 100%)</th><th>WHAT PROJECT IS
(60% - 85%)</th><th>CAN'T DECIDE
(40%-60%)</th><th>WHAT PROJECT IS NOT!
(less than 40%)</th></tr>
<tr><td>WINNER FACELIFT</td><td>Dynamic
Minimal
Friendly
Masculine</td><td>Innovative
Rational
Sophisticated
Futuristic
Fluid
Geometric
Solid
Natural
Robust
Urban</td><td>Cold / warm</td><td>Conventional
Complex
Emotional
Standardized
Traditional
Static
Aggressive
Massive
Organic
Feminine
Artificial
Transparent
Lightweight
Cosy</td></tr>
<tr><td>inTRAIN</td><td>Friendly
Natural
Warm
Futuristic
Innovative
Sophisticated
Fluid</td><td>Dynamic
Lightweight
Transparent</td><td>Minimal / complex
Emotional / rational
Organic / geometric
Feminine / masculine
Urban / cosy</td><td>Conventional
Standardized
Traditional
Static
Aggressive
Massive
Artificial
Solid
Robust
Cold</td></tr>
<tr><td>LIFE</td><td>Innovative
Futuristic
Sophisticated
Complex
Lightweight
Warm
Cozy</td><td>Emotional
Dynamic
Fluid
Organic
Friendly
Transparent</td><td>Natural / artificial
Masculine / feminine</td><td>Conventional
Minimal
Rational
Standardized
Traditional
Static
Aggressive
Massive
Geometric
Robust
Solid
Urban
Cold</td></tr>
</table>

(source: researcher, 2017)

As a general conclusion, we can state that certain features are clearly perceived by clients and partners as Semantic attributes of Almadesign Form Language. The main features (more than 70% of the answers in all 3 projects) are:

- Clients and partners identify in 3 projects in a majority (more than 70%):
    - INNOVATIVE, SOPHISTICATED, FUTURISTIC, DYNAMIC, FLUID, FRIENDLY.

Certain features are not that clearly stated, specifically in some of the projects. This could be due to the questions being badly formulated, as the sets of antagonistic adjectives might not be clear enough, or by means of the understanding everyone does for the visual semantics and its relation to written language. This is always an issue, as people have different interpretations of written words and visual features. The differences maybe born from the project itself, in that it lends to different interpretations depending on the "parts" or the "whole" being observed. This might happen for instance in the case of choosing between masculine and feminine, which might be present in some shapes but not on every detail, as well as the Solid vs Transparent. The adjectives that repeatedly throughout the 3 projects are voted "one" or its "opposite" feature are most likely badly formulated questions, as they are opened to very different interpretations. These are mainly the following pairs of adjectives:

- ORGANIC VS GEOMETRIC; URBAN VS COSY.

Another interesting analysis is to check which adjectives are not considered to be included in the Visual Language of the company. These are:

- Clients and partners DO NOT identify in 3 projects in a majority (more than 70%):
    - CONVENTIONAL; STANDARD; TRADITIONAL; STATIC; MASSIVE; AGGRESSIVE.

Based on the open-question about the relation between Almadesign Visual Language and an automotive brand we can also devise some preliminary conclusions which can help determine the semantics of Almadesign Visual Language as interpreted by clients and partners:

- Clients and partners refer to, in the open question:
    - Alfa Romeo, BMW, Ferrari: brands associated with design, sportiness, dynamics but also sport friendly (Mini Cooper);
    - Citroen or Range Rover: which were associated robustness, practicality and innovation;
    - Specific adjectives are mentioned and confirm the survey questions results: INNOVATION; SOPHISTICATION; DYNAMIC; VISIONARY.

Table 19 - Experimental Study #3: Summary of results

Experimental study #3: Form Language of Almadesign				
Type of data	**Results**	**Winner project**	**inTRAIN project**	**LIFE Project**
Data gathered	16 completed surveys; 740 total "semantic" adjectives;, 240 per project; 16 open-ended answers;			
Quantitative analysis #1	What the project is definitely (85%-100%)	**Dynamic** Minimal Friendly Masculine	Futuristic Innovative Sophisticated **Friendly** Fluid **Natural** **Warm**	**Innovative** **Futuristic** **Sophisticated** Complex Lightweight Warm Cozy
Quantitative analysis #2	Almadesign as an automotive brand	Any innovative brand	"The Almadesign projects indicate this."	
		Citroen	"There is freedom, lightness and originality in	
		BMW	concepts."	
		Sports Vehicle brand	"The form language is similar."	
		Ferrari	"That is their design trend."	
			"Because Almadesign is a machine creating visionary	
		Alfa Romeu	projects for all"	
			"Because it is a design focused company just like	
		AUDI	automotive company Alfa Romeu."	
			"Perceived quality above average, bold design but fully	
		Mini Cooper	functional, deliver as expected"	
		Alfa Romeu	"Sophisticated with some emotion"	
			"Brand associated with robust lines and integrating	
		Range Rover/Evoque	innovative aspects. Dynamism.	
			"Innovative design. Very Convincing. Practical and	
		Lamborghini	robust. Creates new lines that inspire change."	
		Alfa Romeo	"Design, Shape, Future"	
		DS (Citroen)	"Innovative Design."	
		Volvo	"The classic associated with the sophisticated."	
			"Simplicity of Form / Sobriety / Rigor Design /	
		Alfa Romeo	Dynamics / Natural Materials."	
			"For the creativity and design."	

(source: researcher)

PART IV – CASE STUDIES

PART IV: CASE STUDIES

Overview

Part IV – Case Studies reports the fourth Part of this investigation. The work described in this Part was developed during a two-year period of the investigation and includes 3 Case Studies developed by the researcher at Almadesign Studio with 3 of the studio's projects: project WINNER, a coach developed in the automotive area; project InTRAIN an R&D in the railway area; LIFE, an R&D project developed for the aviation sector. The studies were developed by the researcher and were grounded in the literature study providing valuable information. Taking into consideration the 3 research vectors – Context, Syntax and Semantics – the Case Studies aimed to analyse the Form Language in the light of all three vectors. This Part is organized in 3 chapters, each referring to a specific Case Study from #1 to #3.

Structure of Part IV

This part is structured in the following way:

- Chapter 1 discusses the method used in developing the Case Studies framework, describing the methodology and reasons for the different choices made.
- Chapter 2 presents the work developed for Case Study #1: "Project WINNER (Facelift)", including the Objectives, Methodology, Results, Discussion and Conclusion.
- Chapter 3 presents the work developed for Case Study #2: "InTRAIN - Research and Development of Components for Railway Interiors" including the Objectives, Methodology, Results, Discussion and Conclusion.
- Chapter 4 presents the work developed for Case Study #3: "LIFE - Lighter, Friendly and Eco-Efficient Aircraft Cabin" including the Objectives, Methodology, Results, Discussion and Conclusion.
- Chapter 5 concludes this part highlighting how the work developed contributes to the overall objective of the investigation, presenting conclusions and implications for the study of the Form Language of Almadesign studio.

1 Case Study Framework

1.1 *Introduction*

The preliminary Case Study analysis framework was based on the selection of 3 of the studio's most important projects with the objective of analyzing them and establishing patterns which could help define a specific studios Form Language. In order to achieve this, a description of each of the vectors, Context, Form Syntax and Semantics was developed for each project and each projects' phase. A spreadsheet was developed to compile information gathered at Almadesign Studio, for each of the projects. This information included, drawings, photographs, reports, minutes of meetings, publications, etc. The Framework was descriptive using text to fill in each category, but also descriptive by means of visual communication, with the researcher developing specific drawings which cloud isolate constant elements in the Form Syntax of the projects.

1.2 *Objectives*

The following objectives were set for the preliminary Case Study Framework:

- To develop a Framework to analyze Case Study projects in different dimensions: Context, Form Syntax and Form Semantics.
- To cross the information on the 3 research vectors with the projects' different phases: Research, Concept Design, Design Development, Prototyping, Communication;
- To analyze the collect information and try to isolate Constants, Tendencies, Patterns, and trying to uncover differences when comparing the 3 Case Studies.

Being the first Case Study developed, it was fundamental for the investigation to create a specific framework for the Case Study analysis, which is presented in the Methodology. This framework / methodology was then used in all 3 Case Studies in order to gather and analyze similar types of information which could allow for a comparison between the 3 Case Studies in trying to define Almadesign specific Form Language in its Context, Syntax and Semantic vectors.

1.3 ***Methodology***

1.3.1 Dates and sample size

Case Study #1 to #3 were developed in from August 2016 to November 2017. In order to choose the 3 Case Studies a list of all Almadesign projects during the studio's 20 years was developed based on information supplied by the company. The projects were grouped into categories, similar to the categories the studio has used internally, over the years, in order to organize its different business areas such as: transports, product, interiors, communication, evets/shows. These categories were a result of an evolution and their names were slightly changed over the years. Nevertheless, the main significance of the naming and product category was used a guideline by this investigation, according to the studio's work during this period. Based on this Data collection, a spreadsheet was created, grouping the projects in 5 main categories. Over 500 projects were catalogued in this list based on data form the company.From this choice several projects were possible to analyse as Case Studies. Nevertheless, because of time constraints, it was decidied by the researcher and the investigation team that a short list of 3 should be defined. The following spreadsheet shows the studio's list of projects from 1997 to 2016:

	A	B	C	E	F	G
1	Ano	Cliente	Projecto	Fase		
2				Conceito	Desenvolvimento	Produto Final
390	2012	ADIRA	Logótipos máquinas		COMUNICAÇÃO	
391	2012	AICEP	Farnborough		INTERIORES	
392	2012	AMORIM	Railways Interiors Boston		INTERIORES	
393	2012	AMORIM	Brochura Lightweight Solutions		COMUNICAÇÃO	
394	2012	AMORIM	ECOTRAIN Monofolha		COMUNICAÇÃO	
395	2012	AMORIM	ECOTRAIN RII Publicidade		COMUNICAÇÃO	
396	2012	ARALAB	Família I - Câmara Climática		PRODUTO	
397	2012	AUTOFLY	Vídeo promocional		COMUNICAÇÃO	
398	2012	CAETANOBUS	Double Decker Exterior		TRANSPORTES	
399	2012	CAETANOBUS	Probus IVECO		TRANSPORTES	
400	2012	CAETANOBUS	Levante Facelift		TRANSPORTES	
401	2012	CAETANOBUS	Levante Facelift Double Decker	TRANSPORTES		
402	2012	CAETANOBUS	Visualização Winner Marrocos			
403	2012	CAETANOBUS	Visualização Cobus C5 Sintra			
404	2012	CAETANOBUS	Visualização MAN Singapura SMRT	TRANSPORTES		
405	2012	CAETANOBUS	Visualização MIDI			
406	2012	EDAETech	Laser 3D		PRODUTO	
407	2012	EMPORDEF	Simulador de voo		TRANSPORTES	
408	2012	GYROFLY Innovations	Logótipo		COMUNICAÇÃO	
409	2012	LUSOSPACE	Ovan - óculos	PRODUTO		
410	2012	MEP	Projecto IDI, consórcio: AD, INEGI, TEKEVER , EPI		PRODUTO	
411	2012	PEMAS	ASD Painel		COMUNICAÇÃO	
412	2012	PEMAS	Monofolha		COMUNICAÇÃO	
413	2012	SUNVIAUTO	Banco para aeronáutica	INTERIORES		
414	2012	WORTEN	Centro de assistência Autorizado APPLE (Colombo)		INTERIORES	
415	2013	ADIRA	GH Pendural		PRODUTO	
416	2013	ADIRA	Posters Bailarinas		COMUNICAÇÃO	
417	2013	ADIRA	Telas Exteriores 2013		COMUNICAÇÃO	
418	2013	ALMADESIGN	Livro comemorativo - 15 anos		COMUNICAÇÃO	
419	2013	AMORIM	Quickbuild Apresentação		COMUNICAÇÃO	
420	2013	AMORIM	Quickbuild Monofolhas		COMUNICAÇÃO	
421	2013	AMORIM	Quickbuild Eco village & Eco Resort		COMUNICAÇÃO	
422	2013	AMORIM	Quickbuild Eco village & Eco Resort		COMUNICAÇÃO	
423	2013	AMORIM	WallinBlock Brochura		COMUNICAÇÃO	
424	2013	Caetano Aeronautic	Maquela Fábrica		PRODUTO	
425	2013	Caetano Aeronautic	Vídeo promocional		COMUNICAÇÃO	
426	2013	CAETANOBUS	Cobus D2EU		TRANSPORTES	
427	2013	CAETANOBUS	Visualização Levante Livery			
428	2013	CAETANOBUS	Visualização Levante Voyager			
429	2013	CAETANOBUS	Visualização MAN MIDI			
430	2013	CAETANOBUS	Visualização MAN A67 MIDI			
431	2013	CAETANOBUS	Visualização MAN Double Decker			
432	2013	CAETANOBUS	Visualização Probus Livery	TRANSPORTES		
433	2013	CAETANOBUS	Mostruário		COMUNICAÇÃO	

Figure 151 : Spreadsheet with list of Almadesign projects with specific filters (source: researcher, 2017)

In order to choose only 3 projects for the Case Sutdy analysis, the researcher decided to follow two principles in chosing the projects. The first was based on the companies choice of promotional projects, that is, all the projects the company decided to present as their service based results for clients, in the different marketing media over time. This allows for an anysis that is consistent with what clents's knowledge about the company througout the years, that is to say, the Form Language they are familiar with. The information if available in the following media: Company's Website. promotional Brochures and Studio's books (10, 15 ans 20 years comemorative editions).

From the initial list of projects, it was found that due to the very large number of Bus and Coach projects, the Case Studies had to account for these. And hence the most successful in terms of time span and sales was selected: Caetano Winner. Another criteria was the fact that the studio has been developing a lot of R&D projects in the last 10 years, resulting in designs which have been widely published worlwide. In this kind of projects, an "advanced design" approach is taken (this is the expression using in the automotive industry to referre to the automotive studiso of the biggest brands which are responsbile to develop future cars and prototypes, and not production cars). This is to say that designers have a lot of space to innovate, as the project is a R&D effort which means future solutions can be studied with a low TRL withou compromising a specific client's need for the market. It is considered that these projects are able to beeter show design capabiltieis and specific Form Language approaches which can be more interesting towards the research. In this sense, the most emblematic is the CRYSTAL CABIN AWARD 2012 winning project LIFE, which was awarded the most important prize in Aircraft Interiors conceptual projects. Finally, and regrading the same concpet of "advanced design" approach, it was found that due to the Automotive industry being already represented by Caetano Winner project and the Aviation industry by the LIFE project, a railway project would be the way to cover all the studio's most important project areas. So, the project INTRAIN (GOOD DESIGN AWARD 2015) was chosen. The three final choices are presented in Figures 152-154:

- Case Study #1: Project WINNER (Facelift)

Figure 152 : Case Study #1: Project Winner Facelift (source: Almadesign archive)

Almadesign developed several Bus projects during a 20-year collaboration with CaetanoBus. This is the oldest client / partner of the company and its flagship product Winner and Levante has been designed by Almadesign and is now on the 3rd generation, showing the evolution of the company's design language over the years. This project have transformed the company into a player in the automotive sector.

- Case Study #2: Project InTRAIN - Research and Development of Components for Railway Interiors”

Figure 153 : Case Study #2: Project inTRAIN (source: Almadesign archive)

This was a 3-year Railway awarded project, which included different companies in a Consortium and which led Almadesign to be the main supplier of Design Solutions for the Railway Industry in Portugal, namely with CP (Comboios de Portugal) and EMEF (Empresa de Manutenção Ferroviária)[11], which also transformed the company in a player in the sector. This project was awarded the GOOD DESIGN AWARD 2015.

- Case Study #3: Project LIFE – “Lighter, integrated and eco-friendly aircraft interior”

Figure 154 : Case Study #3: Project LIFE (source: Almadesign archive)

The reasons to choose this project are related to the fact it was a 2-year Aviation R&D project, with a large Consortium of National and International companies, awarded the CRYSTAL CABIN AWARD 2012 and widely publicized over the aviation world, which transformed the company in a player in the aviation sector.

1.3.2 Procedure

Case Studies were developed using a template spreadsheet which accounted for the project phases, and the investigation vectors. Regarding the project phases, Almadesign studio follows a specific

[11] Portuguese Railway Maintenance Company

process / methodology in their development, which should account for different levels of analysis of the Case Study framework. Project phases at Almadesign as defined as (Marcelino, 2012):

- Idea generation: planning, research and concept generation
- Development: concept development, product engineering
- Execution: prototype, production
- Communication: promotion, market folllow-up

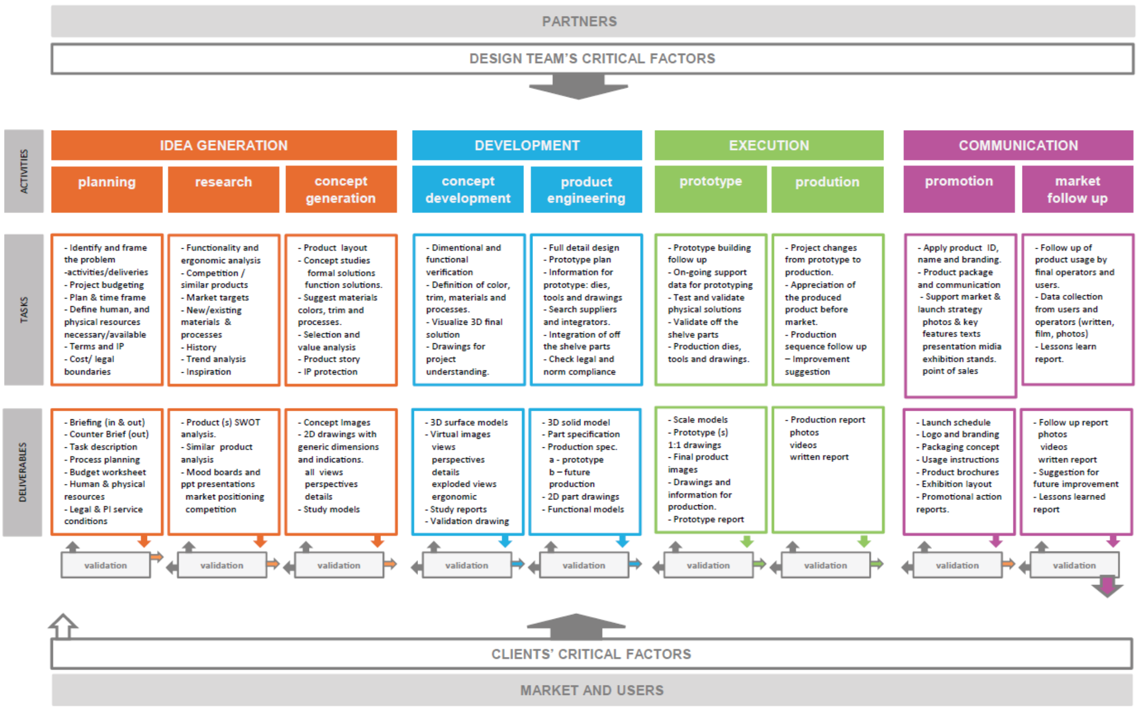


Figure 155 : Almadesign studio activities according to Marcelino (source: Marcelino 2012)[12]

These same categories were used in the Framework build-up, in order to analyze each of the Case Studies in the different project phase and cross it with the investigation vectors. So, in order to analyze each Case Study in the light of the 3 investigation vectors - Context, Form Syntactic and Semantics - a specific methodology named "Framework for Case Study Analysis" was developed by the researcher.

The methodology chosen was to build a spreadsheet with different INPUTS and collect "historic" information on the project based on the company's archives (drawings, presentations, minutes of meetings) and on the researcher experience within the projects. The framework can be used to analyze the material collected in the different project phases – columns in the spreadsheet – which

[12] Reprinted from "Product design: managing the process, the competencies and the culture in a design studio", Marcelino, 2012

range from initial specifications, to design sketches, renderings, files for prototyping, photos from the mock-assembly, etcetera) and different vectors of the investigation – lines in the spreadsheet – which include Context, Form Syntax and Design Semantics. The main goal was to provide an overview description of the project's phases, processes and final results with a "Form Language centered" perspective, accounting for the investigation vectors. These vectors were developed in the following sub-categories in the spreadsheet:

- **CONTEXT:**
  - Internal: Designers, Resources, Methodologies, Tools, Innovation processes, Tools, market "agreements", schedule;
  - External: Client's brief, Social / Economic / Legal, Market / Culture / Inspiration, Tech Trends.
- **FORM SYNTAX:**
  - Practical functions: Function / Performance / Composition, Production technologies / constraints, adaptations;
  - Formal/aesthetic functions: Form language / vocabulary, CMF (colour, materials and finishing).
- **FORM SEMANTICS (connection with Experimental study #3)**
  - Sign / symbolic functions: designer's attribution; clients interpretation (open to many interpretations).

As mentioned before, it was found that besides the spreadsheet containing information about the Case Study – which is very descriptive and analytical as a tool - specific author's drawings should be added to each project, to enrich the Form Syntax analysis by means of a visual representation. It was found that a text description was too abstract and could lead to different interpretations. Hence it was decided to enrich the Case Study methodology with drawings in order to better analyze, identify and isolate different aspects in the Form Syntax of the Visual Language.

To achieve this, three to five images from each project were used as a work base, and from each image different drawings were developed trying to identify the specific Form Syntax elements which define the visual language. A set of colour / material chart was also developed for each project, to be able to map the Colour and Trim developed (still under development).

A first framework chart was developed to include preliminary specifications. To complete the chart, the researcher used information from different sources such as Projects Reports, Minutes of Meetings, interviews to designers and his own experience in the project (when relevant). The following charts present the template spreadsheet developed by the researcher, with the Case Study identification and Data Collection spreadsheet (Figure 156). The complete tables can be accessed in the Annexes. Case Study identification featured the following points:

- Project name; Market segment; Client name; Designers involved; Partner companies; Start Date; Completion Date; Awards;

CATEGORIES FOR ANALYSIS		PROJECT PHASES			
		IDEA GENERATION	DEVELOPMENT	EXECUTION	COMMUNICATION
CONTEXT	INTERNAL (Resources, Methodologies)				
	EXTERNAL (Cultural, Economic, Legal, Market, Tech)				
SYNTAX	PRACTICAL FUNCTIONS (Performance, Technology, Production)				
	LANGUAGE FUNCTIONS (Form elements, Design principles, CMF)				
SEMANTICS	SYMBOLIC FUNCTIONS (Symbols, Icons, Indexs)				
	SYMBOLIC FUNCTIONS (Conotation, Denotation)				

Figure 156 : Case Study Framework: Spreadsheet for data collection (source: researcher, 2017)

The framework was developed and refined along the process. One of the main issues was the amount of information for each project. The selection of the most relevant information was fundamental. Regarding the research vectors, it was found that for each one – Context, Syntax and Semantics – two other groups had to be developed in order to gather all the necessary information. For the Context part, an Internal and External context was defined. For the Syntax, Practical and Language functions were added; finally, for the semantics, Symbolic functions form the designer perspective and form the client / partner perspective were added.

2 Case Studies #1 to #3

2.1 *Introduction*

Case Study #1 is named “Winner (Facelift)” project. This project – and its “brother” project Levante – is the best selling Almadesign project to date. It is a project which started in 2003 with the first generation Winner and Levante (the same design adapted for the UK market) and is still selling as the Levante III in 2017. This is one of the most popular Almadesign projects and also the one which generated higer sales in the bus / coach market, specifically in the UK. Being such a visible and important project for Almadesign, but also because it is an exterior and interior design project which has established a long run cooperation with CaeatnoBus the bus manufcaturer who build the Winner and Enigma, and also because it already has 3 design generations over the years, it was found to be one of the best examples to analyse as a Case Study.

Case Study #2 is named “InTRAIN” project. This project was an R&D FP7 funded project with a consortium of several companies, among them SETSA, Active Space, Almadesign, INEGI, ISQ, Optimal and SpinWorks and EMEF as an important subcontracted partner. The project objectives included the design and development of a suburban railway carriage. The main focus of the project was the integration of eco-efficient, user-friendly materials, tehcnologies and innovative design (Marcelino, 2017). Different systems were designed and developed during the project among them the concept design, passenger layout, seat design, sidewall panels, ceiling panels, accessories, infortainment systems, lighting, etc.

Case Study #3 is named “LIFE” project. This project was an R&D FP7 funded project with a consortium of several companies, among them SETSA, INEGI, Couro Azul, Amorim and Embraer Brasil as an important OEM partner. The project objectives included the design and development of a private jet interior. The main focus of the project was the integration of eco-efficient, lighter, friendly materials and innovative design (Marcelino, 2013). Different systems were designed and developed during the project among them the overall concept design, passenger layout, seat design, sidewall panels, ceiling lighting system, the infotainment sphere, lavatory, bedroom, etcetera.

2.2 *Objectives*

The following objectives were set for Case Studies #1 to #3:

- To analyze the projects in the lens of the three research vectors: Context, Form Syntax and Form Semantics;
- To gather data and cross the information on the 3 research vectors with the project’s different phases: Research, Concept Design, Design Development, Prototyping, Communication;
- To establish patterns, isolate constants; uncover differences when comparing the projects to the other Case Studies.

The same framework / methodology was used in all 3 Case Studies in order to gather and analyze similar types of information which could allow for a comparison between the 3 Case Studies in trying to define Almadesign specific Form Language in its Context, Syntax and Semantic vectors.

2.3 *Methodology*

2.3.1 Dates, participants and sample size

Using the Framework for Case Study analysis, the three projects were analysed by the researcher. The study was developed during a period of about 6 months, during which several changes to the methodology and framework were made. The study was held from June 2017 to November 2017.

2.3.2 Evaluation approach

Case Studies #1 to #3 were a Qualitative study performed by the researcher. The following Table 20 summarizes the evaluation approach developed by the researcher, determining the following aspects:

- Type of study
- What needs to be measured
- Data collection method
- Access issues / Tools
- Timeline
- What was done

Table 20 - Case Studies: Data collection methodology

CASE STUDIES - DATA COLLECTION METHODOLOGY					
Type of study	**What needs to be measured**	**Data to be collected and collection method**	**Access issues / Tools**	**Timeline / Venue**	**What was done**
Qualitative study of project Caetano Winner	Context, Form Syntax and Form Semantics	Text reports, images, photographs, drawings, renderings; CONTEXT template spreadsheet with information form the projects; FORM SYNTAX using drawings in a specific methodology; data from Experimental Study #3 was used to fill in the FORM SEMANTICS	Amount of information available for each project; bias related to researcher being a part of the project development team;	October 2016, July 2017;	Template spreadsheet was filled in; renderings of the project and drawings were developed indicating main design elements form the researcher's point of view; a second set of drawings was developed in order to analyze the evolution of the Winner / Levante coaches, resulting in drawings which show the evolution of the Form Language over the years;

(source: researcher, 2017)

2.3.3 Procedure

Case Study #1 to #3 were developed using the spreadsheet template which was filled in by the researcher. The information gathered resulted from the analysis of projects technical reports, minutes of meetings, presentations and form the designer own experience. The evaluation approach of Case Study #1 involved the following phases:

- **CONTEXT:**
  - Gather information on project;
  - Fill in the template spreadsheet with information from the projects based on documentation from each project (reports, presentations, minutes of meetings) and his own personal experience as parte of the development team.
- **FORM SYNTAX:**
  - Gather information on project;
  - Fill in the template spreadsheet;
  - Critical analysis using renderings / photos, drawings and text;
  - Synthetis drawings.
- **FORM SEMANTICS:**
  - Gathered information from Experimental Study #3 to fill in the template spreadsheet.

2.4 *Case Study #1 - Data collection*

Reports, presentations, minutes of meetings, renderings and photographs from project Winner Facelift were collected. From this information, the spreadsheet template was filled in, for each of the investigation vectors. The following data was collected (Table 21). Figure 157 shows an example of the completed spreadsheet. The complete chart can be assessed in Appendix 4.

Table 21 - Case Study #1: Data collection and analysis

DATA COLLECTION AND ANALYSIS			
Data gathered	**Context**	**Form syntax**	**Form semantics**
1 template spreadsheet filed in; Form elements Drawings Drawings with Form Language evolution over time.	Textual analysis on the information gathered by researcher.	Textual analysis on drawings, synthesis of form elements used, synthesis of Form Language evolution	Critic analysis using text;

(source: researcher, 2017)

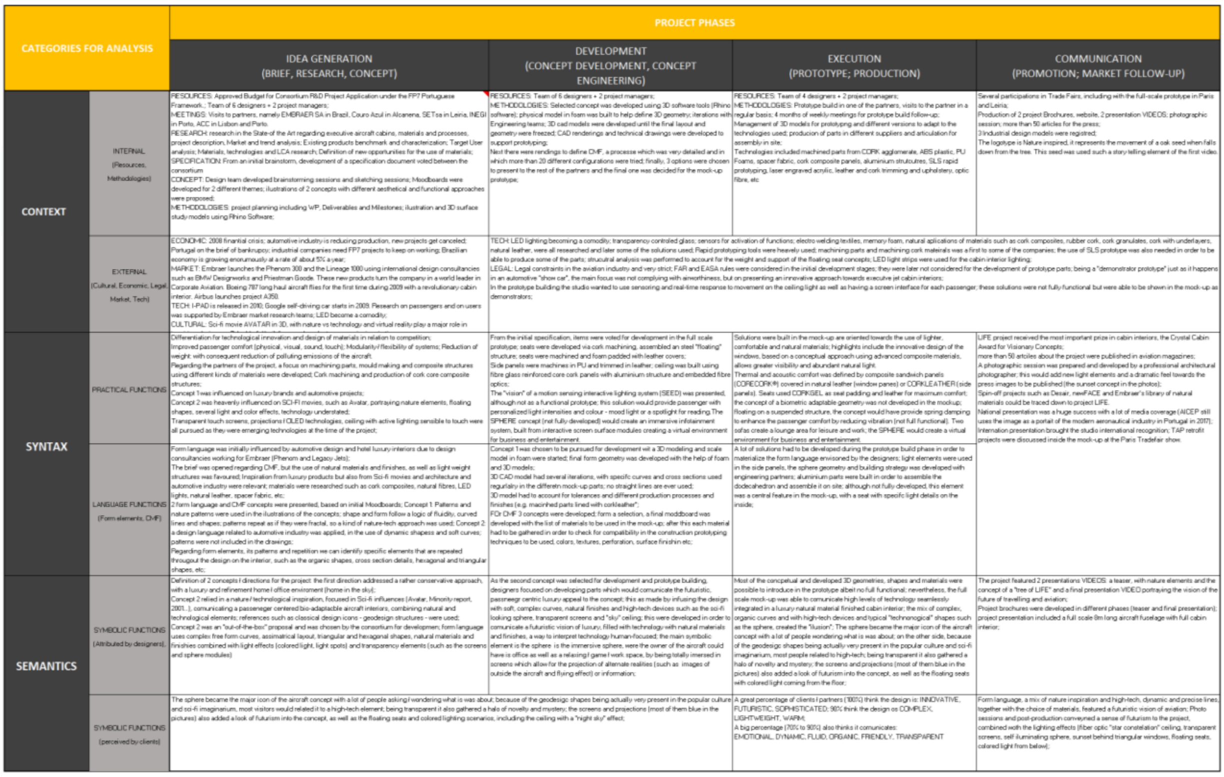


Figure 157 : Case Study #1: Spreadsheet with data collection (source: researcher, 2017)

2.5 *Case Study #1 - Results*

Results were gathered in a period of a few months, with information being fed into the spreadsheet by the researcher. When a preliminary version was completed, the document was revised by 3 of the studio's designers who actively participated in the projects. The Case Study identification is the following (Figure 158):

CASE STUDY #1 - IDENTIFICATION	
Project name	WINNER Facelift
Market segment	Automotive
Client	CAETANOBUS
Designers	JRM, AC, RO, MD, GJ, ER, CF
Partner companies	-
Start Date	Jan 2011
Completion Date	July 2011
Awards	-

Figure 158 : Case Study identification (source: researcher, 2017)

For each of the investigation vectors the spreadsheet was filled in and the following paragraphs are a transcription of the text included with specific images for each of the vectors in each of the project's phase (Idea Generation, Development, Execution and Communication).

2.5.1 CONTEXT - Internal (studio resources and methodologies)

- IDEA GENERATION (including Brief, Research and Concept Design):
  - **Resources:** approved budget; team of 4 designers + 1 project manager;
  - **Meetings:** manufacturing facilities; engineering and marketing meetings;
  - **Specification:** development of a specification document with features to include in the new model;
  - **Research:** analysis of bus and automotive industry;
  - **Concept:** design team developed brainstorming sessions and sketching sessions; illustrations of 3 concepts with different aesthetical and functional approaches; methodologies: Photoshop illustration and 3D surface study models using rhino software.
- DEVELOPMENT (including Concept development and Engineering):
  - **Resources:** approved budget; team of 4 designers + 1 project manager;
  - **Methodologies:** model developed using 3d software tools (rhino software); several iterations with engineering teams;
  - **3D cad models** were developed until the final layout and geometry were freezed;
  - **Cad renderings** were developed to support prototyping.

- EXECUTION (including Prototype and Production):
    - **Resources:** approved Budget; Team of 4 designers + 1 project manager;
    - **Methodologies:** prototype built in client's facilities and suppliers using rapid prototyping tools and fiberglass parts; changes in the prototype were made before final molds were prepared;
    - Designers accompanied prototyping with visits and meetings in the clients; documents with changes and improvements; Testing and validation procedures by client engineering).
- COMMUNICATION (including Promotion and Market Follow-up):
    - Not applicable.

2.5.2 CONTEXT - External (Cultural, Economic, Legal, Market, Tech)

- IDEA GENERATION, DEVELOPMENT, EXECUTION and COMMUNICATION:
    - **Economic:** 2012 Portugal assistance program; unemployment rates going up; automotive industry reducing production, not investing;
    - **Tech:** tesla presents first electrical mass production car; I-pad is launched in 2010; quadcopters go massive in production; Led market parts are available for headlights; led lights for the backlights; daytime running lights were applied; cameras;
    - **Legal:** Bus and coach Regulation 66 (structure)
    - **Market:** benchmark bus: .Irizar, Setra, Vanhool; Mercedes
    - **Cultural:** Prometheus movie; cosmic motors; oblivion.

2.5.3 FORM SYNTAX - Practical functions (including functions and performance)

- IDEA GENERATION:
    - New headlights, front grille, bumper;
    - Parts division according to C5; new rearview mirrors;
    - New lateral glazing (symmetrical);
    - New door design (straight not curved); new rubber profiles;
    - "B" Pillar in glass and FGRP;
    - New top, ceiling and profiles for water;
    - Simplified assembly, less parts;
    - Back lights with larger area; pantograph engine door.
- DEVELOPMENT:
    - Steel structure;
    - Roof profiles in FGRP;
    - LEDs;
    - Daytime running lights;
    - Models and prototypes.
- EXECUTION:
    - Automatic door;
    - 3-part front (2 side rotating + grille pantograph);
    - Asymmetrical rearview mirrors;

- automatic side doors;
- driver boomerang window and simplified "B" pillar;
- LED rear lights;
- rear grille with larger air outtakes;
- front and ceiling side sills for water;
- welded steel structure;
- foam isolation;
- side panels in aluminum, FGRP front and rear parts.

- COMMUNICATION:
  - Not applicable.

2.5.4 FORM SYNTAX - Language functions (form elements, cmf)

- IDEA GENERATION:
  - 4 concepts were initially proposed (Figure 159);
  - All concepts carried out an evolution of the form language developed in earlier models (Winner I and Winner II) with new side windows and front and rear parts;
  - Different colours for 4 concepts, in order to help with the concept differentiation.

Figure 159 : Case Study #1: Concept drawings (source: Almadesign archive, 2012)

- DEVELOPMENT:
  - The sloping all around the body line, sloping front, boomerang headlights in the front and back; specific details were added such as the definition of a detail grille design; careful care was given to the surface cross sections both in the front and back

section, where slightly curved surfaces and specific fillet were used to maintain the concept design form elements and retaining the technical feasibility of the parts and respective production methods.

- EXECUTION:
    - Going from concept to development, some design features were changed / adapted due to production constraints such as the availability of market parts (for the headlights) which only allow for a certain headlight diameter, the availability of DRL for the front, the number of parts and part division;
    - Side windows became symmetrical (were asymmetrical with Winner Bus) and a slight curve dropping earlier was now a part of the DLO which also finishes earlier due to the door changes;
    - Paint scheme adapted to production constraints (masking to be avoided; parts with different color should be different parts, etcetera), see Figure 160.

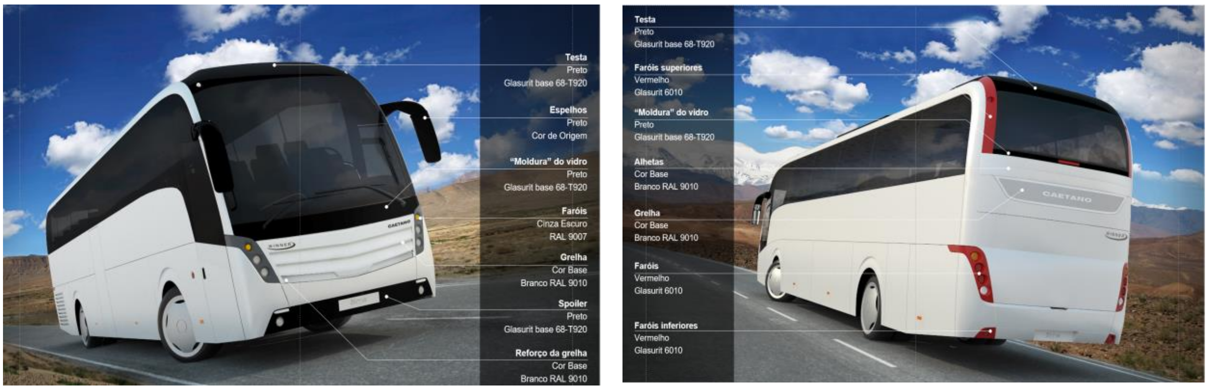


Figure 160 : Case Study #1: CMF details for production (source: Almadesign archive, 2012)

- COMMUNICATION:
    - Not applicable;

2.5.5 FORM SEMANTICS - Symbolic functions (attributed by designers)

- IDEA GENERATION:
    - Initial concepts carried out form elements from previous models with small changes; a continuity approach was devised;
    - Front concepts had more "horizontal" elements or more diagonal and aggressive ones; Caetano grille had a vertical or horizontal "tooth";

    - Nevertheless, all concepts had a "friendly" expression, (smiling) and all carried a dynamic sloping line in the side glazing which is clean and minimal.
- DEVELOPMENT:
    - The chose concept featured an evolution of the vertical front headlights into a "boomerang" shape design element (such as the tail lamps);
    - Boomerang shape headlights are metaphors of speed and dynamic movement / flight; the front grille maintains big dimensions and carries the "lines" starting form horizontal into dynamic towards the center of the front bumper; large grille normally indicate large cars and top of the line models;
    - At the back the boomerang shape of the backlights was kept, although a larger wider look is now present due to technical constraints;
    - The horizontal grille is now bigger and more detailed, with a big branded element;
    - Horizontal grilles are reminiscent of 70's supercars (used them in their engines lids); repeated horizontal lines are metaphors for speed (streamlining air movements);
    - Wheel arches are recessed and sculpted, which add interest to the minimal flat sides, and communicate a better "stance" (increase the perceived size of the wheels and add sculpture to a very flat side body).
- EXECUTION:
    - Because of technical constraints the side of the bus were turned symmetrical from the previous models; also, a sloped side curve had to be added to improve passenger visibility on a "sloping" interior floor;
    - Different non-symmetrical rearview mirror had to be used in the front; this asymmetrical look on the mirrors could eventually lead to a strange "uncanny" feeling due to its strange asymmetry; back lamps being more robust lose some of its elegance form previous models;
    - CMF specification used white, black and red parts; the white overall color, together with "darkened" side glasses, and details in matte black (such as a part of the front bumper or the rear one) makes for a look of black and white which resembles SCI-FI classics such as Star Wars, Stormtroopers (a tendency in the automotive design market).
- COMMUNICATION:
    - Not applicable.

2.5.6 FORM SEMANTICS - Symbolic functions (perceived by clients)

- IDEA GENERATION, DEVELOPMENT, EXECUTION and COMMUNICATION:
    - Choices were made during the concept and development phase by the client’s CEO, engineering and marketing teams;
    - Form elements in line with the previous models was clearly preferred by the client (do not change a "winner team" is very applicable in this case!)
    - MAYA principles appear to work here: most advanced yet acceptable; radical changes in form elements were not well received;
    - Bus gained robustness and complexity but lost elegance and simplicity (minimalism);

- A great percentage of clients / partners (90% to 100%) think the design is: DYNAMIC; MINIMAL; FRIENDLY; MASCULINE;
- A big percentage (70% to 90%) also thinks it communicates: INNOVATIVE; RATIONAL; SOPHISTICATED; FUTURISTIC; FLUID; GEOMETRIC; SOLID; ARTIFICIAL; ROBUST; URBAN.

2.6 *Case Study #1 - Discussion*

Project WINNER was developed with Almadesign's oldest client (and also the first one) Caetanobus. This attest to a 20-year relationship between client and design studio which is prove of a long relation of trust and achievement together. Caetanobus Form Language derives a lot form the work developed over the years by Almadesign, and so it is very much aligned with most of the company's visual language specific syntax. Being a "client" project and not an R&D effort, designers typically have less "liberty" to explore concepts and have bigger technical restrictions (cost, production, manufacturability, maintenance, certification, etcetera). The project was a complete design proposal with a lot of units being built, which means the materialization of a concept, form development through manufacturing, solving a lot of technical problems which existed in previous models. Different processes and methodologies were used, from brainstorm sessions, preliminary specifications, moodboards, sketching, 3D modelling, scale model making, rendering, prototype building, mock-up assembly and project dissemination. Specific design elements (form language, shapes, cross sections, functions, CMF, light use, etcetera) are identifiable and consistently used throughout the project. Clients and partners identify in a clear way (more than 70% of the answers) certain features of the project such as: Innovative, Minimal, Rational, Sophisticated, Futuristic, Dynamic, Fluid, Friendly and Masculine.

The Framework used in this analysis was descriptive using text to fill in each category, but also descriptive by means of visual communication, with the researcher developing specific drawings which cloud isolate constant elements in the Form Syntax of the projects. Figure 161 to 164 describe the main Form Syntax Elements for the project, as well as their organization and also some notes on Form Semantics, according to the researcher.

The following objectives were set and partially achieved, for Case Study #1:

- To analyze Caetano Winner project in different dimensions: projects' Context, Form Syntax and Form Semantics – This was achieved via the information described in the spreadsheet and in the chapter's text.
- To cross the information on the 3 research vectors with the project's different phases: Research, Concept Design, Design Development, Prototyping, Communication – The framework spreadsheet crosses the information between each project phase and investigation vector.
- To analyze the collect information and try to establish patterns, isolate constants, uncover differences – This analysis is presented in the next pages, through drawings developed by the researcher (Figure 161 to 164); the drawings cover the analysis of both Form Syntax elements, their organization and also Form Semantics form the perspective of the researcher (comments on the images) and according to clients and partners (Figure 164, with keywords).

Figure 161 : Case Study #1: Syntax and Semantics analysis (source: researcher, 2017)

Figure 162 : Case Study #1: Syntax and Semantics analysis (source: researcher, 2017)

Figure 163 : Case Study #1: Syntax and Semantics analysis (source: researcher, 2017)

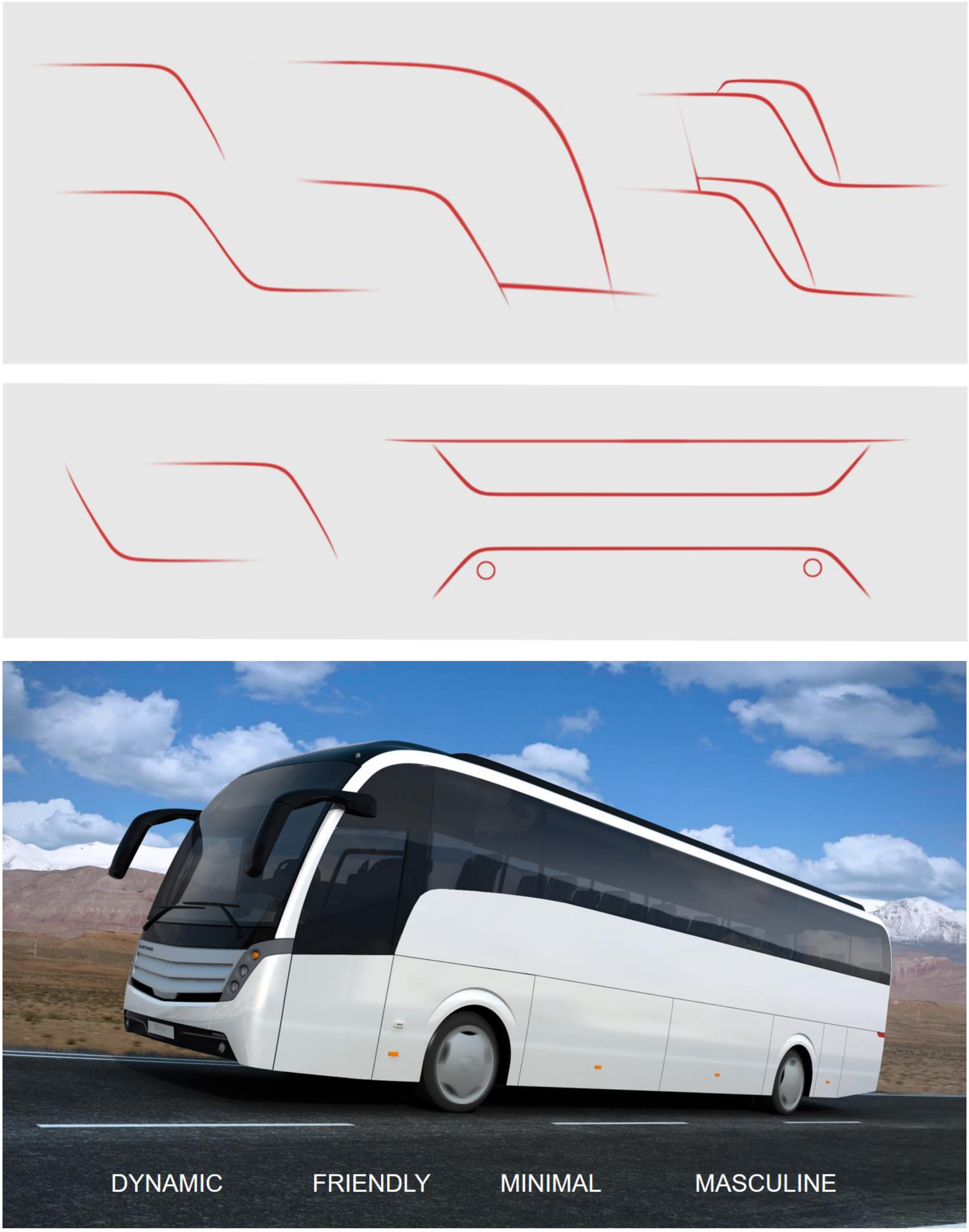


Figure 164 : Form Syntax elements and main keywords by clients / partners (source: researcher, 2017)

Figure 164 brings together the main Form Syntax elements used in the project using an analytical approach. The most relevant elements from the front, back and side views were chosen by the researcher and organized as shown. From the left to the right, it is possible to see how specific elements such as the “boomerang shapes” and “tensioned curves” are used and combined in a variety of sizes, scales and combinations. By using these design elements and organizing them with specific design principles – symmetry, repetition, rhythm, variety, proportion, harmony, unity – the result is larger than the sum of parts. It is the organization – and not just the elements themselves – which is of the most importance. The same elements re-arranged without design principles would result in a different design -and would semantically communicate a different message.

CMF (color, material and finish) represent a small aspect of the exterior albeit an important one. By using only black and white for the main panels, and grey and red for details (such as front grille and backlights) the maximum contrast between parts is achieved, specifically in the side glazing and a very clear reading of the panel divisions is highlighted, bringing rhythm and unity to the design. The black and white CMF is also reminiscent of SCI-FI references such as high-tech machinery and robots (Starwars Stormtroopers come to mind…). Together with the form elements, they bring together a Form Language which clients and partners characterize as Dynamic, Friendly, Minimal and Masculine.

2.7 ***Case Study #1 - Appendix***

During the investigation, another coach was developed by the studio for its oldest client Caetanobus. The Wiiner III (Levante III in the UK version) is the sixth generation of a product which started with the Enigma bus, the first studio's commission. It seemed a perfect opportunity to make a point of situation concerning the Form Syntax developed for the Caetano Brand. This new model was presented in October 2017 and featured a new Form Language for the Caetanobus premium product. Figures 165 and 166 present the final product, as presented at the Kortrjik Bus Word Trade Fair in Belgium.

Figure 165 : Caetanobus Levante II, designed by Almadesign (source: Almadesign archives, 2017)

Figure 166 : Caetanobus Levante II, designed by Almadesign (source: Almadesign archives, 2017)

The following drawings (Figure 167 to Figure 169) were developed by the researcher. They depict 20 years of Caetano's Form Language developed by Almadesign studio. The visualization of the different generations together in one drawing provides good insight into the evolution of the studio's Form Language over the years, together with its first and oldest client. This was found to be an interesting analysis, to complete Case Study #1. Original size drawings can be accessed in the Annexes.

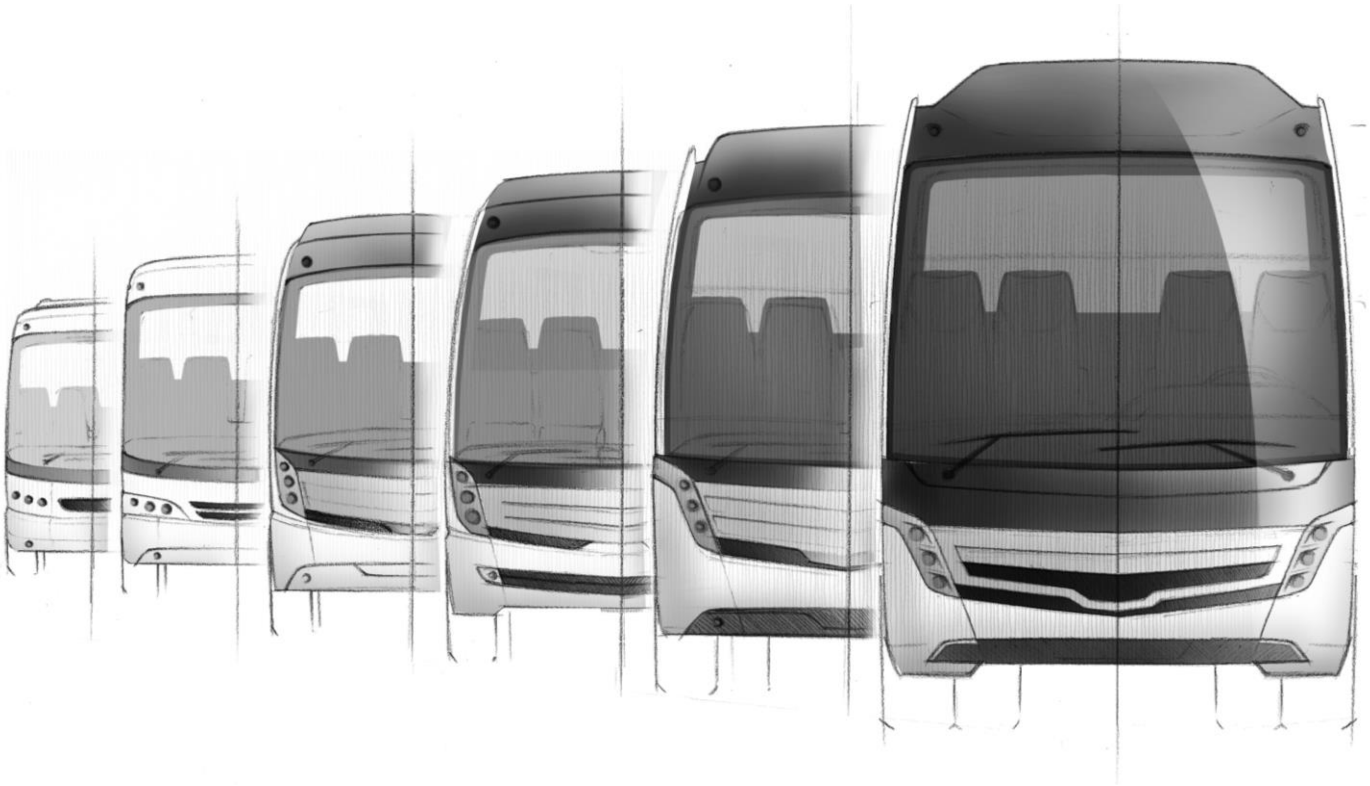


Figure 167 : 6 generations of Caetanobus coaches – Front Views (source: researcher, 2017)

Figure 168 : 6 generations of Caetanobus coaches – Back Views (source: researcher, 2017)

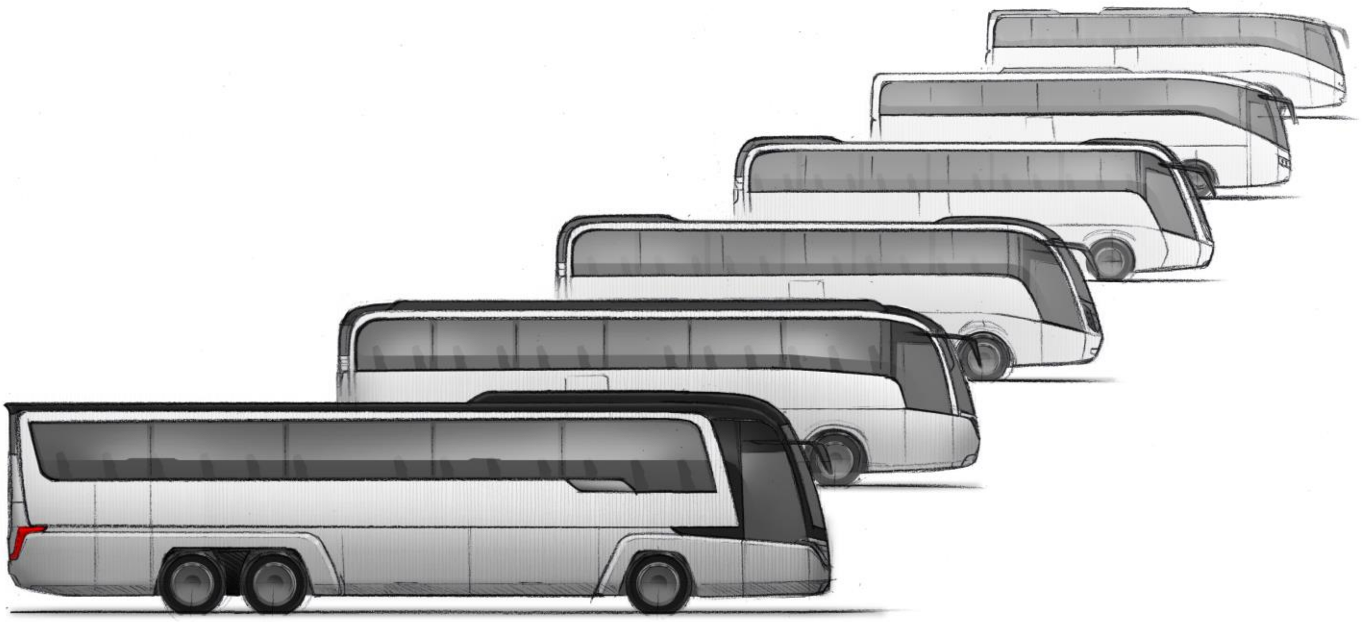


Figure 169 : 6 generations of Caetanobus coaches – Side Views (source: researcher, 2017)

The drawings depict the evolution of Caetanobus's premium product, the Enigma and Winner / Levante coaches. The first two drawings represent the begging of the collaboration between Almadesign and Cateanobus, with the Enigma and Enigma II coaches (years 1997 and 2000). Following the two first models, the Winner coach (named Levante in the UK RHD version) is presented in three generations: Winner (2003), Winner II (2008) and Winner Facelift (2012). Finally, the latest development form the Studio, the Levante III (and Winner III) coach (2017).

From the first generation, the sloping dynamic side view divided in three volumes (lower side covers, central body and window glazing) is present. A single line contours the whole bodywork from the "belt" line, just above the wheel arches.. The first generation featured a simple front view with circular off-the-shelve headlights and taillights. For the second model, Engima II a simpler side profile kept the side view minimal, but front and back lights were now included in a contoured part, allowing for a clearer definitions of the "eyes".

The Winner coach represented a departure for the studio's Form Language, with a side profile – much rounder at the back and inclined at the front, and a continuous top surface, from the back to the front reminding the "look and feel" of high-speed trains. The headlights and backlights were now included in a specific produced part and defined a more vertical Form Language, with the "boomerang" and "arrow" shapes combined with soft curves. Winner was asymmetrical, with side windows featuring two different configurations between left and right.

The following generations technical improvements but also compromised some of the design decisions of the first model. This is true of the headlights and backlights, which were off-the-shelf parts again in case of Winner II and Winner Facelift. The roof profiles also went through major changes due to isolation technical requirements and the asymmetrical layout was abandoned for a symmetrical one. Nevertheless the front grille design and headlights were gradually refined and Winner Facelift shows a successful result with design cues which were to be refined in the final model presented, the Levante / Winner III.

For this model, a complete new approach towards the structure, interior and exterior design was developed. The result is also a completely new design which presents more edges, sharper curves and radius and a more sculpted side profile, specifically in the front and back wheel arches. The front end is now visually more connected with the side view, via a dynamic “diagonal cut” which connects headlights and side panels. The driver space and entrance doors are now clearly defined from the outside. At the back the side profile is now much steeper due to aerodynamic improvements, and features an evolution of the backlights which are now visually connected and topped by a grille to cool the engine.

Globally, we can consider that every model has a connection with its predecessor, with three big changes in the Form Language: Enigma I and II; Winner I, II and Facelift; Winner III. Currently Winner Facelift is still being sold as a premium product, as well as Levante Facelift. The first two prototypes of the latest model - Levante III and Winner III - were finished during the final part of this investigation and are presently (December 2017) in tests for final production.

2.8 ***Case Study #2 - Data collection***

Reports, presentations, minutes of meetings, renderings and photographs from project inTRAIN were collected. From this information, the spreadsheet template was filled in, for each of the investigation vectors. The following data was collected (Table 22 and Figure 170). Complete filled in spreadsheet can be accessed in Appendix 4.

Table 22 - Case Study #2: Data collection methodology

DATA COLLECTION AND ANALYSIS			
Data gathered	**Context**	**Form syntax**	**Form semantics**
1 template spreadsheet filed in; Photographs + Form elements Drawings 3 Drawings with Form Language evolution over time	Textual analysis on the information gathered by researcher	Textual analysis on drawings, synthesis of form elements used, synthesis of Form Language evolution	Critic analysis using text;

(source: researcher)

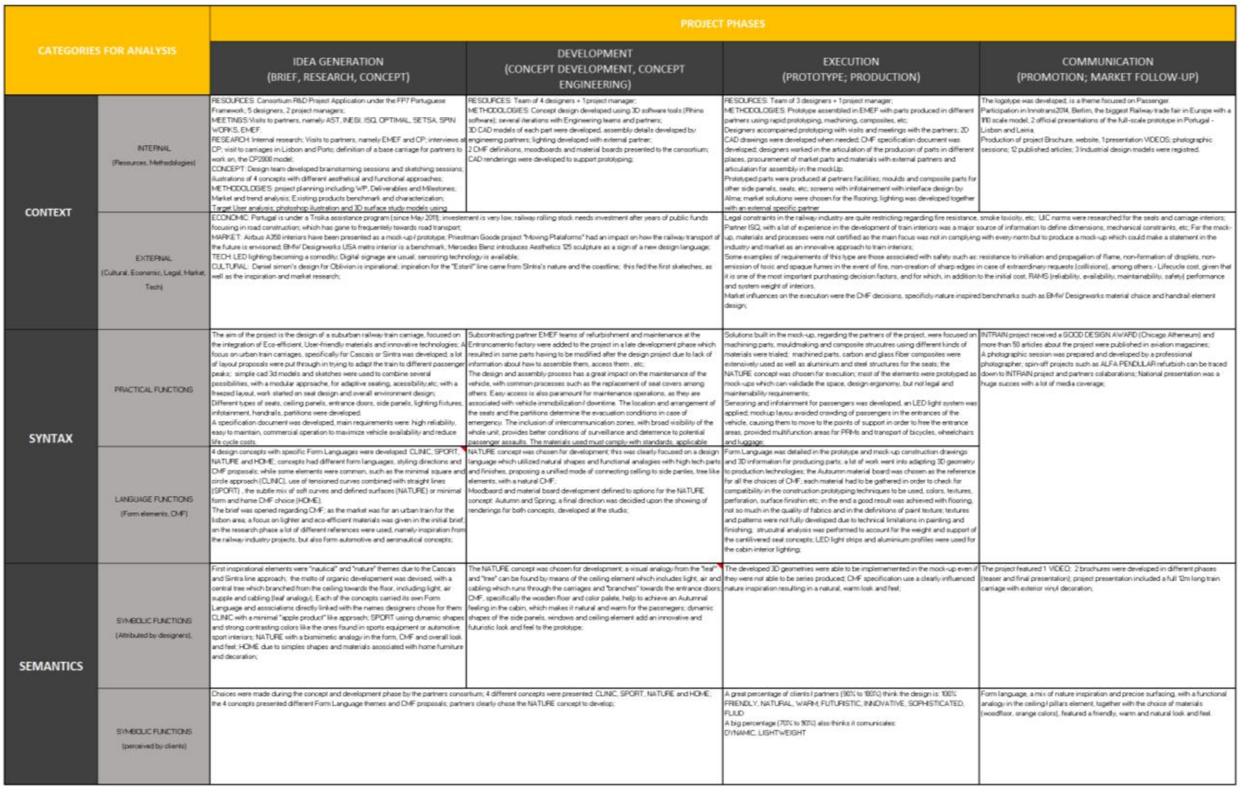


Figure 170 : Case Study #2: Spreadsheet with data collection (source: researcher, 2017)

2.9 *Case Study #2 - Results*

Results were gathered in a period of a few months, with information being fed into the spreadsheet by the researcher. When a preliminary version was completed, the document was revised by 4 of the studio's designers who actively participated in the projects. The Case Study identification is the following (Figure 171):

CASE STUDY #2 - INTRAIN	
Project name	inTRAIN
Market segment	Railway
Client / Partner	inTRAIN Consortium
Designers	JRM, AC, ER, MD, RO, GJ, CF
Partner companies	AST, INEGI, OPTIMAL, SETsa, SPINWORKS, EMEF
Start Date	Feb 2012
Completion Date	Jan 2015
Awards	Good Design Award 2015

Figure 171 : Case Study identification (source: researcher)

For each of the investigation vectors the spreadsheet was filled in and the following paragraphs are a transcription of the text included with specific images for each of the vectors in each of the project's phase (Idea Generation, Development, Execution and Communication).

2.9.1 CONTEXT - Internal (studio resources and methodologies)

- IDEA GENERATION (including Brief, Research and Concept Design):
    - **Resources:** Consortium R&D Project Application under the FP7 Portuguese Framework; 5 designers, 2 project managers;
    - **Meetings:** Visits to partners, namely AST, INEGI, ISQ, OPTIMAL, SETSA, SPIN WORKS, EMEF;
    - **Research:** Internal research; Visits to partners, namely EMEF and CP; interviews at CP; visit to carriages in Lisbon and Porto; definition of a base carriage for partners to work on, the CP2000 model;
    - **Concept:** Design team developed brainstorming sessions and sketching sessions; illustrations of 4 concepts with different aesthetical and functional approaches;
    - **Methodologies:** project planning including WP, Deliverables and Milestones; Market and trend analysis; Existing products benchmark and characterization;
    - Target User analysis; Photoshop illustration and 3D surface study models using Rhino Software.
- DEVELOPMENT (including Concept development and Engineering):

  - **Resources:** Team of 4 designers + 1 project manager;
  - **Methodologies:** Concept design developed using 3D software tools (Rhino software); several iterations with Engineering teams and partners;
  - 3D CAD models of each part were developed, assembly details developed by engineering partners; lighting developed with external partner;
  - 2 CMF definitions, mood boards and material boards presented to the consortium; CAD renderings were developed to support prototyping.
- EXECUTION (including Prototype and Production):
  - **Resources:** Team of 3 designers + 1 project manager;
  - **Methodologies:** Prototype assembled in EMEF with parts produced in different partners using rapid prototyping, machining, composites, etcetera;
  - Designers accompanied prototyping with visits and meetings with the partners; 2D CAD drawings were developed when needed; CMF specification document was developed; designers worked in the articulation of the production of parts in different places, procurement of market parts and materials with external partners and articulation for assembly in the mock-up;
  - Prototyped parts were produced at partners facilities, moulds and composite parts for other side panels, seats, etcetera; screens with infotainment with interface design by Alma; market solutions were chosen for the flooring; lighting was developed together with an external specific partner.
- COMMUNICATION (including Promotion and Market Follow-up):
  - The logotype was developed, is a theme focused on Passenger;
  - Participation in Innotrans2014, Berlin, the biggest Railway trade fair in Europe with a 1/10 scale model; 2 official presentations of the full-scale prototype in Portugal - Lisbon and Leiria;
  - Production of project Brochure, website, 1 presentation VIDEOS; photographic sessions; 12 published articles; 3 Industrial design models were registered.

2.9.2 CONTEXT - External (Cultural, Economic, Legal, Market, Tech)

- IDEA GENERATION, DEVELOPMENT:
  - **Economic:** Portugal is under a Troika assistance program (since May 2011); investment is very low; railway rolling stock needs investment after years of public funds focusing in road construction; which has gone to frequently towards road transport;
  - **Market:** Airbus A350 interiors have been presented as a mock-up / prototype; Priestman Goode project "Moving Plataforms" had an impact on how the railway transport of the future is envisioned; BMW Designworks USA metro interior is a benchmark; Mercedes Benz introduces Aesthetics 125 sculpture as a sign of a new design language;
  - **Tech:** LED lighting becoming a commodity; Digital signage are usual; sensoring technology is available;

  - **Cultural:** Daniel Simon's design for Oblivion is inspirational; inspiration for the "Estoril" line came from Sintra nature and the coastline; this fed the first sketches, as well as the inspiration and market research.
- EXECUTION and COMMUNICATION:
  - Legal constraints in the railway industry are quite restricting regarding fire resistance, smoke toxicity, etc; UIC norms were researched for the seats and carriage interiors; Partner ISQ, with a lot of experience in the development of train interiors was a major source of information to define dimensions, mechanical constraints, etc; For the mock-up, materials and processes were not certified as the main focus was not in complying with every norm but to produce a mock-up which could make a statement in the industry and market as an innovative approach to train interiors;
  - Some examples of requirements of this type are those associated with safety such as: resistance to initiation and propagation of flame, non-formation of droplets, non-emission of toxic and opaque fumes in the event of fire, non-creation of sharp edges in case of extraordinary requests (collisions), among others.- Lifecycle cost, given that it is one of the most important purchasing decision factors, and for which, in addition to the initial cost, RAMS (reliability, availability, maintainability, safety) performance and system weight of interiors;
  - Market influences on the execution were the CMF decisions, specifically nature inspired benchmarks such as BMW Designworks material choice and handrail element design.

2.9.3 FORM SYNTAX - Practical functions (including functions and performance)

- IDEA GENERATION:
  - The aim of the project is the design of a suburban railway train carriage, focused on the integration of Eco-efficient, User-friendly materials and innovative technologies; A focus on urban train carriages, specifically for Cascais or Sintra was developed; a lot of layout proposals were put through in trying to adapt the train to different passenger peaks; simple cad 3d models and sketches were used to combine several possibilities, with a modular approaches, for adaptive seating, accessibilities; with a freezed layout, work started on seat design and overall environment design;
  - Different types of seats, ceiling panels, entrance doors, side panels, lighting fixtures, infotainment, handrails, partitions were developed;
  - A specification document was developed, main requirements were: high reliability, easy to maintain, commercial operation to maximize vehicle availability and reduce life cycle costs.
- DEVELOPMENT:
  - Subcontracting partner EMEF teams of refurbishment and maintenance at the Entroncamento factory were added to the project in a late development phase which resulted in some parts having to be modified after the design project due to lack of information about how to assemble them, access them, etc.

    - The design and assembly process have a great impact on the maintenance of the vehicle, with common processes such as the replacement of seat covers among others. Easy access is also paramount for maintenance operations, as they are associated with vehicle immobilization / downtime. The location and arrangement of the seats and the partitions determine the evacuation conditions in case of emergency. The inclusion of intercommunication zones, with broad visibility of the whole unit, provides better conditions of surveillance and deterrence to potential passenger assaults. The materials used must comply with standards, applicable legislation and risk analyzes arising from specific operating conditions. Efficiency of assembly by reducing the number of components, quick fixing and lack of adjustment and fittings to the assembly (quality of the assembly project). Comfort of the passengers achieved in ease of movement, information availability, interior noise attenuation, natural and artificial lighting, availability of Multifunctional Areas.
- EXECUTION:
    - Solutions built in the mock-up, regarding the partners of the project, were focused on machining parts, toolmaking and composite structures using different kinds of materials were trialed; machined parts, carbon and glass fiber composites were extensively used as well as aluminum and steel structures for the seats; the NATURE concept was chosen for execution; most of the elements were prototyped as mock-ups which can validate the space, design ergonomics, but not legal and maintainability requirements;
    - Sensoring and infotainment for passengers was developed, an LED light system was applied; mockup layout avoided crowding of passengers in the entrances of the vehicle, causing them to move to the points of support to free the entrance areas, provided multifunction areas for PRMs and transport of bicycles, wheelchairs and luggage.
- COMMUNICATION:
    - INTRAIN project received a GOOD DESIGN AWARD (Chicago Atheneum) and more than 50 articles about the project were published in aviation magazines;
    - A photographic session was prepared and developed by a professional photographer; spin-off projects such as ALFA PENDULAR refurbish can be traced down to INTRAIN project and partners collaborations; National presentation was a success with a lot of media coverage.

2.9.4 FORM SYNTAX - Language functions (form elements, CMF)

- IDEA GENERATION (Figure 172 and 173):
    - 4 design concepts with specific Form Languages were developed: CLINIC, SPORT, NATURE and HOME; concepts had different form languages, styling directions and CMF proposals; while some elements were common, such as the minimal square and circle approach (CLINIC), use of tensioned curves combined with straight lines (SPORT), the subtle mix of soft curves and defined surfaces (NATURE) or minimal form and home CMF choice (HOME);

- The brief was opened regarding CMF; as the market was for an urban train for the Lisbon area; a focus on lighter and eco-efficient materials was given in the initial brief; on the research phase, a lot of different references were used, namely inspiration from the railway industry projects, but also from automotive and aeronautical concepts.

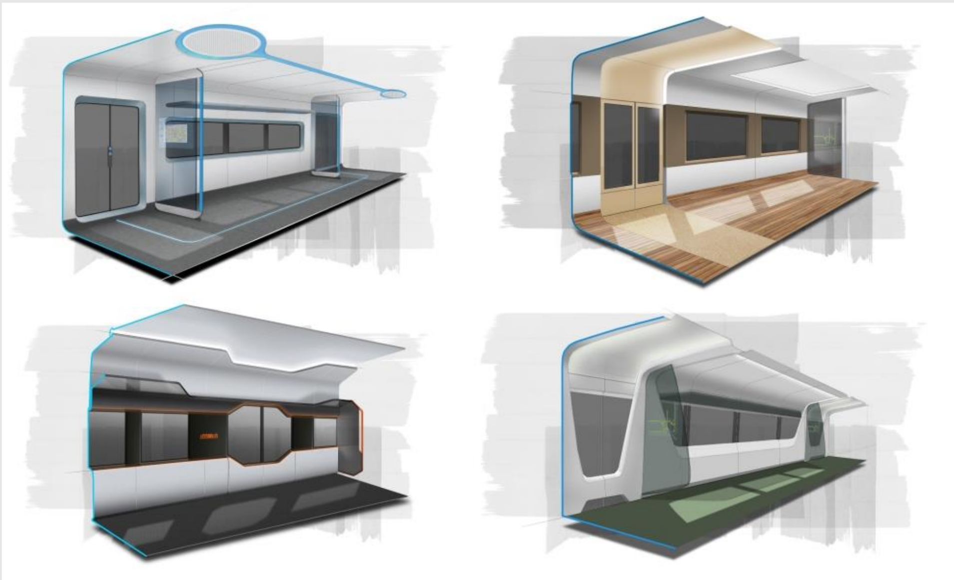


Figure 172 : Case Study #2: Concept drawings (source: Almadesign archive, 2012)

- DEVELOPMENT:
  - NATURE concept was chosen for development; this was clearly focused on a design language which utilized natural shapes and functional analogies with high tech parts and finishes, proposing a unified mode of connecting celling to side panels, tree like elements, with a "nature" inspired CMF (Figure 174);
  - Mood board and material board development defined to options for the NATURE concept: Autumn and Spring; a final direction was decided upon the showing of renderings for both concepts, developed at the studio.

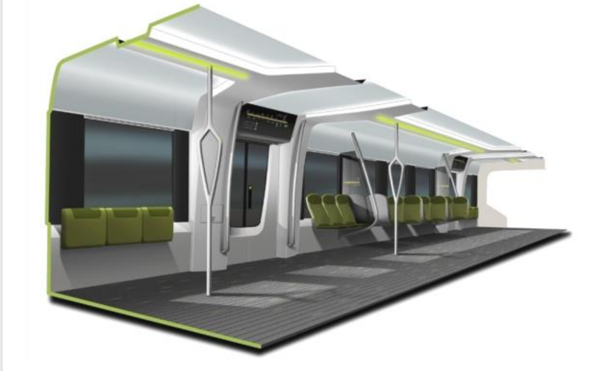


Figure 173 : Case Study #2: Concept refinement drawings (source: Almadesign archive, 2013)

Figure 174 : Case Study #2: CMF proposals (source: Almadesign archive, 2013)

- EXECUTION:
    - Form Language was detailed in the prototype and mock-up construction drawings and 3D information for producing parts; a lot of work went into adapting 3D geometry to production technologies; the Autumn material board was chosen as the reference for all the choices of CMF (Figure 175) ; each material had to be gathered in order to check for compatibility in the construction prototyping techniques to be used, colors, textures, perforation, surface finishing etcetera; in the end a good result was achieved with flooring, not so much in the quality of fabrics and in the definitions of paint texture; textures and patterns were not fully developed due to technical limitations in painting and finishing; structural analysis was performed to account for the weight and support of the cantilevered seat concepts; LED light strips and aluminum profiles were used for the cabin interior lighting.

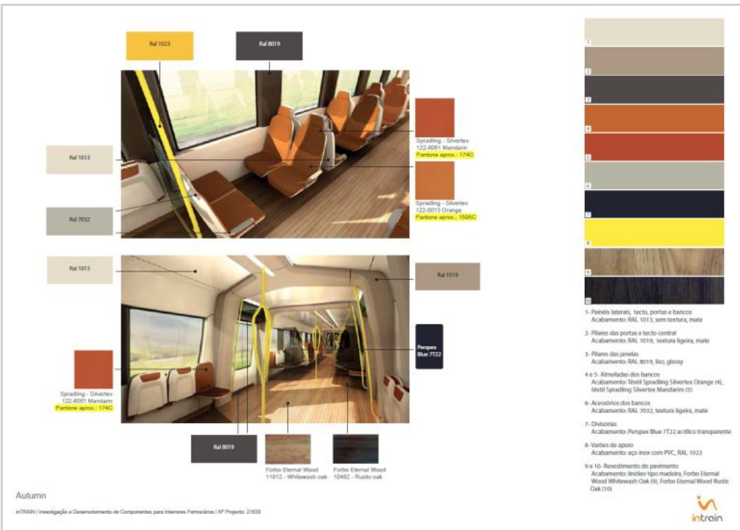


Figure 175 : Case Study #2: CMF development board (source: Almadesign archive, 2013)

- COMMUNICATION:
  - Not applicable in this project;

2.9.5 FORM SEMANTICS - Symbolic functions (attributed by designers)

- IDEA GENERATION:
  - First inspirational elements were "nautical" and "nature" themes due to the Cascais and Sintra line approach; the motto of organic development was devised, with a central tree which branched from the ceiling towards the floor, including light, air supple and cabling (leaf analogy); Each of the concepts carried its own Form Language and associations directly linked with the names designers chose for them: CLINIC with a minimal "apple product" like approach; SPORT using dynamic shapes and strong contrasting colors like the ones found in sports equipment or automotive sport interiors; NATURE with a biomimetic analogy in the form, CMF and overall look and feel; HOME due to simples shapes and materials associated with home furniture and decoration.
- DEVELOPMENT:
  - The NATURE concept was chosen for development; a visual analogy from the "leaf" and "tree" can be found by means of the ceiling element which includes light, air and cabling which runs through the carriages and "branches" towards the entrance doors; CMF, specifically the wooden floor and color palette, help to achieve an Autumnal feeling in the cabin, which makes it natural and warm for the passengers; dynamic shapes of the side panels, windows and ceiling element add an innovative and futuristic look and feel to the prototype.
- EXECUTION:
  - The developed 3D geometries could be implemented in the mock-up even if they were not able to be series produced; CMF specification use a clearly influenced nature inspiration resulting in a natural, warm look and feel.
- COMUNICATION:
  - The project featured 1 VIDEO; 2 brochures were developed in different phases (teaser and final presentation); project presentation included a full 12m long train carriage with exterior vinyl decoration.

2.9.6 FORM SEMANTICS - Symbolic functions (perceived by clients)

- IDEA GENERATION AND DEVELOPMENT:
  - Choices were made during the concept and development phase by the partners' consortium; 4 different concepts were presented: CLINIC, SPORT, NATURE and HOME; the 4 concepts presented different Form Language themes and CMF proposals; partners clearly chose the NATURE concept to develop.
- EXECUTION:
  - A great percentage of clients / partners (90% to 100%) think the design is: 100% FRIENDLY, NATURAL, WARM; FUTURISTIC, INNOVATIVE, SOPHISTICATED, FLUID

- A big percentage (70% to 90%) also thinks it communicates: DYNAMIC, LIGHTWEIGHT.

- COMMUNICATION:
    - Form language, a mix of nature inspiration and precise surfacing, with a functional analogy in the ceiling / pillars element, together with the choice of materials (wood floor, orange colors), featured a friendly, warm and natural look and feel.

2.10 ***Case Study #2 - Discussion***

Project inTRAIN was a 3-year complex project, involving not only designers but other specialists from different areas. Being an R&D "future" project, designers had more "liberty" to explore concepts with less technical restrictions (no certification for airworthiness, the kind every airline or general aviation aircraft needs to be allowed to fly, was needed). The "Nature" theme was inspired by the landscapes around Lisbon (the project was intended to be an urban train interiors for Cascais or Sintra lines), specifically the nature around Sintra and the coastline and sea influences around Cascais, together with the incorporation of technological innovations. Although the project was a concept design proposal for a future train, a mock-up (scale 1:1) was built, which means all the concepts had to be materialized in a physical prototype, which by itself presented a lot of challenges to the designers and their concept design. Different processes and methodologies were used, from brainstorm sessions, preliminary specifications, Moodboards, sketching, 3D modelling, scale model making, rendering, prototype building, mock-up assembly and project dissemination. Specific design elements (form language, shapes, cross sections, functions, CMF, light use, etc) are identifiable and consistently used throughout the project. Solutions developed in the project include an emotional, fluid form language. The interior layout was developed with focus on passenger needs, allowing for different types of seating needs over the day. The most efficient distribution can be decided via flip-up seats and large entrance halls to avoid bottle necks at peak times. There is space for transportation of large objects (strollers, wheelchairs or bicycles). The light and air ducts work together in the ceiling central element, which allows for variable LED light. This element connects ceiling and side panels in a fluid – artery like – natural element. The seats, CMF are designed using a common design language, analyzed in more detail in the next few pages (Figures 176-179). inTRAIN project was built as a real-scale prototype, which meant most of the solutions had to be fully developed for a prototype phase.

As with the previous chapter, Case Study #2 was developed using a specific framework – spreadsheet and drawings - which cloud isolate constant elements in the Form Language of the projects. Figures 176 to 179 describe the main Form Syntax Elements for the project, as well as their organization and also some notes on Form Semantics, according to the researcher. The following objectives were set and partially achieved, for Case Study #2:

- To analyze inTRAIN project in different dimensions: projects' Context, Form Syntax and Form Semantics – This was achieved via the information described in the spreadsheet and in the chapter's text.
- To cross the information on the 3 research vectors with the project's different phases: Research, Concept Design, Design Development, Prototyping, Communication – The framework spreadsheet crosses the information between each project phase and investigation vector.
- To analyze the collect information and try to establish patterns, isolate constants, uncover differences – This analysis is presented in the next pages, through drawings developed by the researcher< the drawings cover the analysis of both Form Syntax elements, their organization and also Form Semantics form the perspective of the researcher (comments on the images) and according to clients and partners (Figure 179, with keywords).

Figure 176 : Case Study #2: Syntax and Semantics analysis (source: researcher, 2017)

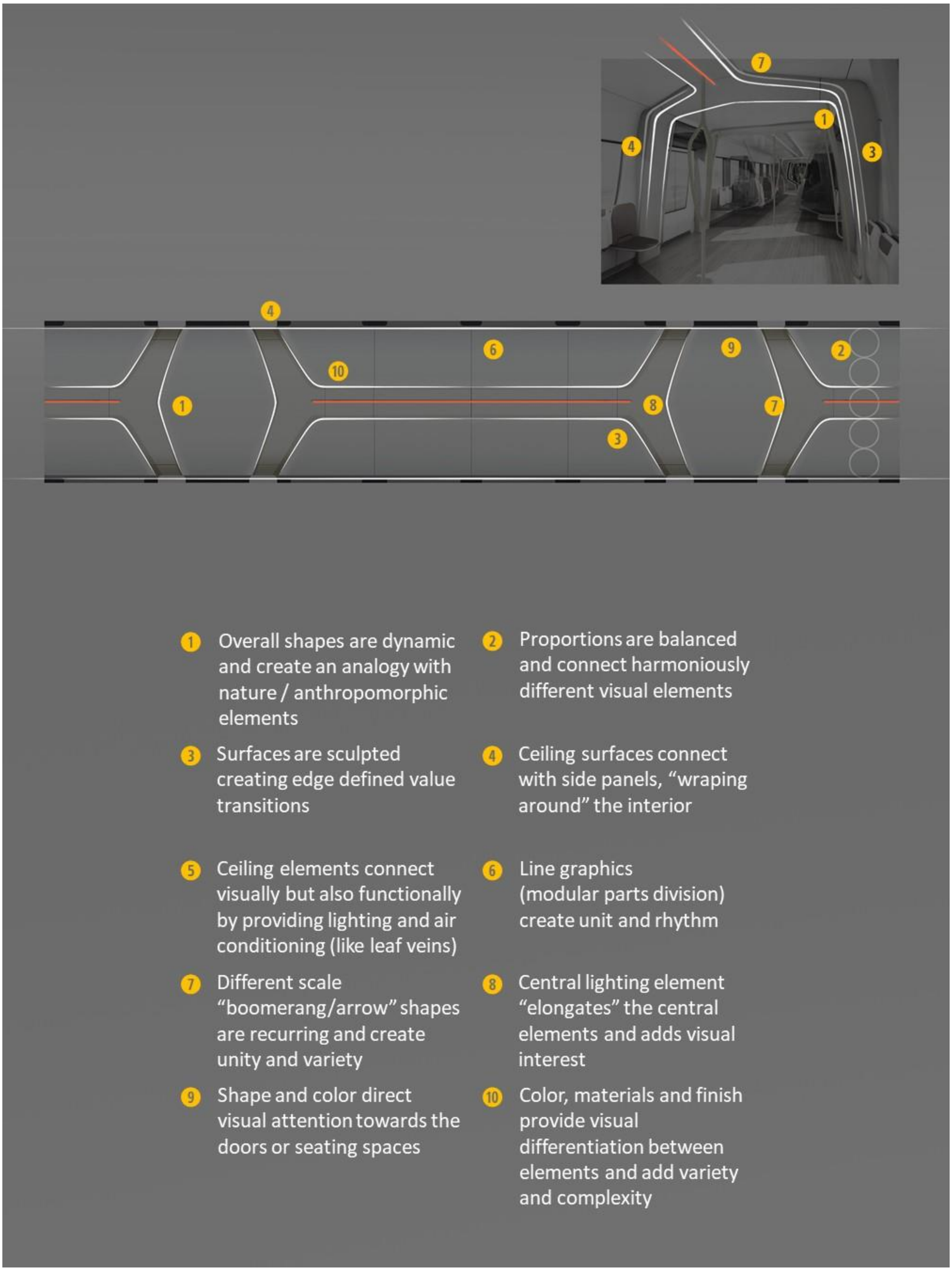


Figure 177 : Case Study #2: Syntax and Semantics analysis (source: researcher, 2017)

Figure 178 : Case Study #2: Syntax and Semantics analysis (source: researcher, 2017)

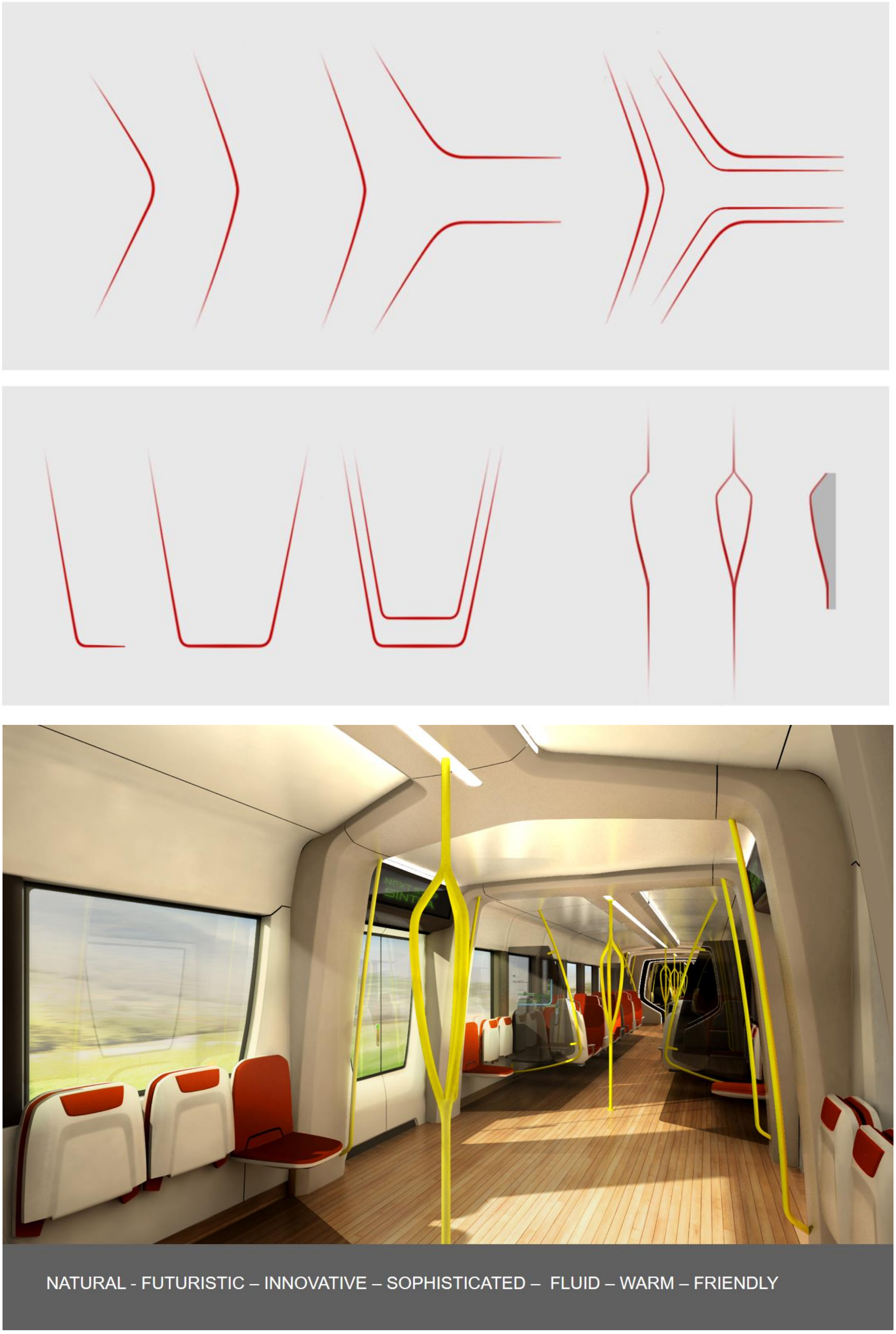


Figure 179 : Case Study #2: Syntax and Semantics analysis (source: researcher, 2017)

Figure 179 brings together the main Form Syntax elements used in the project using an analytical approach. The most relevant elements from Figures 176, 177 and 178 were chosen by the researcher and organized as shown. Just as with the previous Case Study, if we observe from the left to the right, it is possible to see how specific elements such as the “V” shapes and “tensioned curves” are used and combined in a variety of sizes, scales and combinations. Again, by using these design elements and organizing them with specific design principles – symmetry, repetition, variety, proportion, harmony, unity – the result is larger than the sum of parts. It is the organization – and not just the elements themselves – which is of the most importance. Some of the elements are used throughout the train carriage, from the “cross section” elements to the ceiling and the seats. The ceiling is a powerful element and unites top, side and floor panels in a continuous shape, made up of the same design elements.

CMF (color, material and finish) represent a fundamental asset in the project, as they bring the warmth and natural materials “look and feel” to the environment. By using textured, colored flooring, together with an “Autumn” color choice (beige, orange, yellow) the project communicates a warm, natural “look and feel”. Color and finish also separate and highlight the different functional areas (e.g. ceiling with air and light systems; seating; handrails). Together with the form elements, CMF brings together a Form Language which clients and partners characterize as Natural, Futuristic, Innovative, Sophisticated, Fluid, Warm and Friendly.

2.11 ***Case Study #3 - Data collection***

Reports, presentations, minutes of meetings, renderings and photographs from project LIFE were collected. From this information, the spreadsheet template was filled in, for each of the investigation vectors. The following data was collected (Table 23 and Figure 180). The complete spreadsheet filled in can be accessed in Appendix 4.

Table 23 - Case Study #3: Data collection methodology

DATA COLLECTION AND ANALYSIS			
Data gathered	**Context**	**Form syntax**	**Form semantics**
1 template spreadsheet filed in; Form elements Drawings	Textual analysis on the information gathered by researcher	Textual analysis on drawings, synthesis of form elements used, synthesis of Form Language evolution	Critic analysis using text;

(source: researcher)

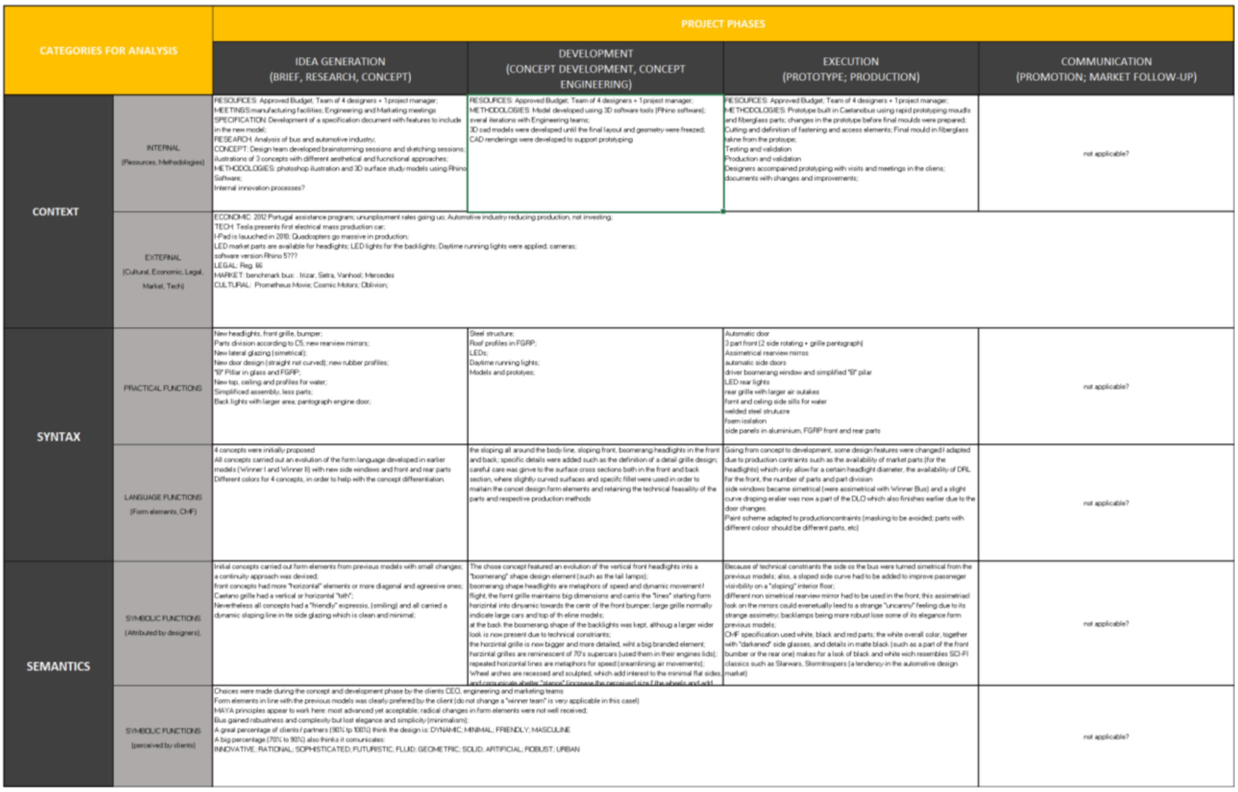


Figure 180 : Case Study #3: Spreadsheet with data collection (source: researcher)

2.12 *Case Study #3 - Results*

Results were gathered in a period of a few months, with information being fed into the spreadsheet by the researcher. When a preliminary version was completed, the document was revised by 4 of the studio’s designers who actively participated in the projects. The Case Study identification is the following (Figure 181).

CASE STUDY #3 - LIFE	
Project name	LIFE
Market segment	Aviation
Client / Partner	LIFE Consortium
Designers	JRM, AC, GJ, ER, CF, RO, JM
Partner companies	COURO AZUL, INEGI, SETsa, ACC, EMBRAER
Start Date	Jul 2009
Completion Date	Jul 2011
Awards	Crystal Cabin Award 2012

Figure 181 : Case identification (source: researcher)

For each of the investigation vectors the spreadsheet was filled in and the following paragraphs are a transcription of the text included with specific images for each of the vectors in each of the project’s phase (Idea Generation, Development, Execution and Communication).

2.12.1 CONTEXT - Internal (studio resources and methodologies)

- IDEA GENERATION (including Brief, Research and Concept Design):
  - **Resources:** Approved Budget for Consortium R&D Project Application under the FP7 Portuguese Framework.; Team of 6 designers + 2 project managers;
  - **Meetings:** Visits to partners, namely EMBRAER SA in Brazil, Couro Azul in Alcanena, SETsa in Leiria, INEGI in Porto, ACC in Lisbon and Porto;
  - **Research:** research in the State-of the Art regarding executive aircraft cabins, materials and processes, project description, Market and trend analysis; Existing products benchmark and characterization; Target User analysis; Materials, technologies and LCA research; Definition of new opportunities for the use of materials;
  - **Specification:** From an initial brainstorm, development of a specification document voted between the consortium;
  - **Concept:** Design team developed brainstorming sessions and sketching sessions; Mood boards were developed for 2 different themes; illustrations of 2 concepts with different aesthetical and functional approaches were proposed;

  - **Methodologies:** project planning including WP, Deliverables and Milestones; illustration and 3D surface study models using Rhino Software.
- DEVELOPMENT (including Concept development and Engineering):
  - **Resources:** Team of 6 designers + 2 project managers;
  - **Methodologies:** Selected concept was developed using 3D software tools (Rhino software); physical model in foam was built to help define 3D geometry; iterations with Engineering teams; 3D cad models were developed until the final layout and geometry were freeze; CAD renderings and technical drawings were developed to support prototyping;
  - Next there were renderings to define CMF, a process which was very detailed and in which more than 20 different configurations were tried; finally, 3 options were chosen to present to the rest of the partners and the final one was decided for the mock-up prototype.
- EXECUTION (including Prototype and Production):
  - **Resources:** Team of 4 designers + 2 project managers;
  - **Methodologies:** Prototype build in one of the partners, visits to the partner in a regular basis; 4 months of weekly meetings for prototype build follow-up;
  - Management of 3D models for prototyping and different versions to adapt to the technologies used; production of parts in different suppliers and articulation for assembly in site;
  - Technologies included machined parts from CORK agglomerate, ABS plastic, PU Foams, spacer fabric, cork composite panels, aluminum structures, SLS rapid prototyping, laser engraved acrylic, leather and cork trimming and upholstery, optic fiber, etcetera.
- COMMUNICATION (including Promotion and Market Follow-up):
  - Several participations in Trade Fairs, including with the full-scale prototype in Paris and Leiria;
  - Production of 2 project Brochures, website, 2 presentation VIDEOS; photographic session; more than 50 articles for the press;
  - 3 Industrial design models were registered;
  - The logotype is Nature inspired, it represents the movement of an oak seed when falls down from the tree. This seed was used such a story telling element of the first video.

2.12.2 CONTEXT - External (Cultural, Economic, Legal, Market, Tech)

- IDEA GENERATION:
  - **Economic:** 2008 financial crisis; automotive industry is reducing production; new projects get canceled; Portugal on the brief of bankruptcy; industrial companies need FP7 projects to keep on working; Brazilian economy is growing at a rate of about 5% a year;
  - **Market:** Embraer launches the Phenom 300 and the Lineage 1000 using international design consultancies such as BMW Designworks and Priestman Goode. These new products turn the company in a world leader in Corporate Aviation. Boeing 787 long

haul aircraft flies for the first time during 2009 with a revolutionary cabin interior. Airbus launches project A350.
  - **Tech:** I-PAD is released in 2010; Google self-driving car starts in 2009. Research on passengers and on users was supported by Embraer market research teams; LED become a commodity;
  - **Cultural:** Sci-fi movie AVATAR in 3D, with nature vs technology and virtual reality play a major role in inspiring designers; Zaha Hadid buildings and products are a major inspiration.
- DEVELOPMENT, EXECUTION and COMMUNICATION:
  - **Tech:** LED lighting becoming a commodity; transparency controlled glass; sensors for activation of functions; electro welding textiles, memory foam, natural applications of materials such as cork composites, rubber cork, cork granulates, cork with underlayers, natural leather, were all researched and later some of the solutions used; Rapid prototyping tools were heavily used; machining parts and machining cork materials was a first to some of the companies; the use of SLS prototype was also needed in order to be able to produce some of the parts; structural analysis was performed to account for the weight and support of the floating seat concepts; LED light strips were used for the cabin interior lighting;
  - **Legal:** Legal constraints in the aviation industry and very strict; FAR and EASA rules were considered in the initial development stages; they were later not considered for the development of prototype parts; being a "demonstrator prototype" just as it happens in an automotive "show car", the main focus was not complying with airworthiness, but on presenting an innovative approach towards executive jet cabin interiors;
  - In the prototype building the studio wanted to use sensoring and real-time response to movement on the ceiling light as well as having a screen interface for each passenger; these solutions were not fully functional but were able to be shown in the mock-up as demonstrators.

2.12.3 FORM SYNTAX - Practical functions (including functions and performance)

- IDEA GENERATION:
  - Differentiation for technological innovation and design of materials in relation to competition;
  - Improved passenger comfort (physical, visual, sound, touch); Modularity / flexibility of systems; Reduction of weight: with consequent reduction of polluting emissions of the aircraft;
  - Regarding the partners of the project, a focus on machining parts, mold making and composite structures using different kinds of materials were developed; Cork machining and production of cork core composite structures;
  - Concept 1 was influenced on luxury brands and automotive projects;
  - Concept 2 was heavenly influenced on SCI-FI movies, such as Avatar, portraying nature elements, floating shapes, several light and color effects, technology understated;

  - Transparent touch screens, projections / OLED technologies, ceiling with active lighting sensible to touch were all pursued as they were emerging technologies at the time of the project.
- DEVELOPMENT:
  - From the initial specification, items were voted for development in the full-scale prototype; seats were developed via cork machining, assembled a steel "floating" structure; seats were machined and foam padded with leather covers;
  - Side panels were machines in PU and trimmed in leather; ceiling was built using fiber glass reinforced core cork panels with aluminum structure and embedded fiber optics;
  - The "vision" of a motion sensing interactive lighting system (SEED) was presented, although not as a functional prototype; this solution would provide passenger with personalized light intensities and color - mood light or a spotlight for reading. The SPHERE concept (not fully developed) would create an immersive infotainment system, built from interactive screen surface modules creating a virtual environment for business and entertainment.
- EXECUTION:
  - Solutions were built in the mock-up are oriented towards the use of lighter, comfortable and natural materials; highlights include the innovative design of the windows, based on a conceptual approach using advanced composite materials, allows greater visibility and abundant natural light.
  - Thermal and acoustic comfort was defined by composite sandwich panels (CORECORK®) covered in natural leather (window panes) or CORKLEATHER (side panels). Seats used CORKGEL as seat padding and leather for maximum comfort; the concept of a biometric adaptable geometry was not developed in the mockup; floating on a suspended structure, the concept would have provided spring damping to enhance the passenger comfort by reducing vibration (not fully functional). Two sofas create a lounge area for leisure and work; the SPHERE would create a virtual environment for business and entertainment.
- COMMUNICATION:
  - LIFE project received the most important prize in cabin interiors, the Crystal Cabin Award for Visionary Concepts;
  - more than 50 articles about the project were published in aviation magazines;
  - A photographic session was prepared and developed by a professional architectural photographer; this would add new light elements and a dramatic feel towards the press images to be published (the sunset concept in the photos);
  - Spin-off projects such as Desair, newFACE and Embraer's library of natural materials could be traced down to project LIFE;
  - National presentation was a huge success with a lot of media coverage (AICEP still uses the image as a portrait of the modern aeronautical industry in Portugal in 2017); International presentation brought the studio international recognition; TAP retrofit projects were discussed inside the mock-up at the Paris Trade fair show.

2.12.4 FORM SYNTAX - Language functions (form elements, CMF)

- IDEA GENERATION:
  - Form language was initially influenced by automotive design and hotel luxury interiors due to design consultancies working for Embraer (Phenom and Legacy Jets);
  - The brief was opened regarding CMF, but the use of natural materials and finishes, as well as light weight structures was favored; Inspiration from luxury products but also from Sci-fi movies and architecture and automotive industry were relevant; materials were researched such as cork composites, natural fibers, LED lights, natural leather, spacer fabric, etc.;
  - 2 form language and CMF concepts were presented, based on initial Mood boards (Figure 182);
  - Concept 1: Patterns and nature patterns were used in the illustrations of the concepts; shape and form follow a logic of fluidity, curved lines and shapes; patterns repeat as if they were fractal, so a kind of nature-tech approach was used;
  - Concept 2: a design language related to automotive industry was applied, in the use of dynamic shapes and soft curves; patterns were not included in the drawings;
  - Regarding form elements, its patterns and repetition we can identify specific elements that are repeated throughout the design on the interior, such as the organic shapes, cross section details, hexagonal and triangular shapes, etc..

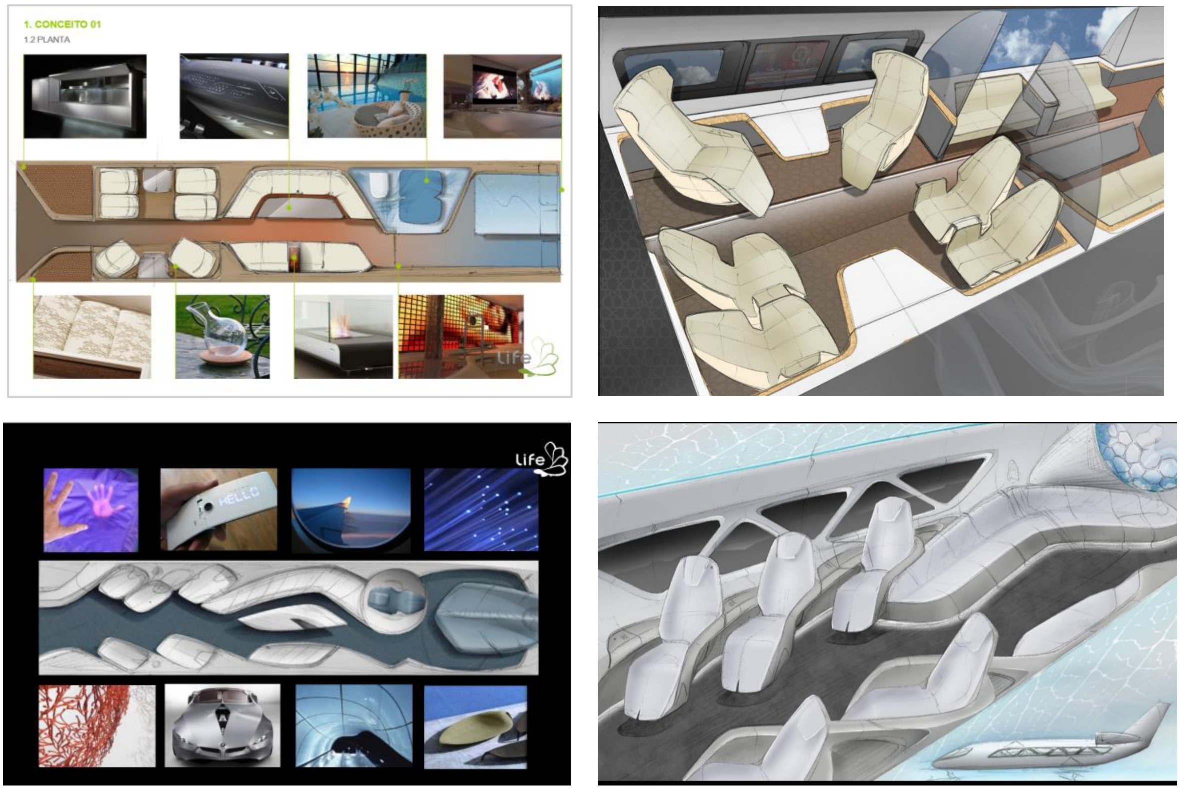


Figure 182 : Case Study #3: Concept drawings (source: Almadesign)

- DEVELOPMENT:
    - Concept 2 was chosen to be pursued for development with a 3D modeling and scale model in foam were started; final form geometry was developed with the help of foam and 3D models (Figure 183);
    - 3D CAD model had several iterations, with specific curves and cross sections used regularly in the different mock-up parts; no straight lines are ever used;
    - 3D model had to account for tolerances and different production processes and finishes (e.g. machined parts lined with cork-leather";
    - For CMF several concepts were developed; form a selection, a final mood board was developed with the list of materials to be used in the mock-up; after this each material had to be gathered in order to check for compatibility in the construction prototyping techniques to be used, colors, textures, perforation, surface finishing etcetera; (Figure 184 and 185).

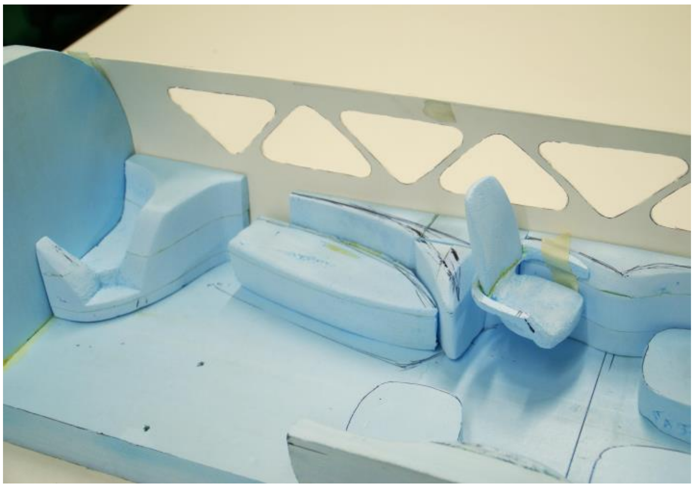


Figure 183 : Case Study #3: Study models (source: Almadesign archive, 2010)

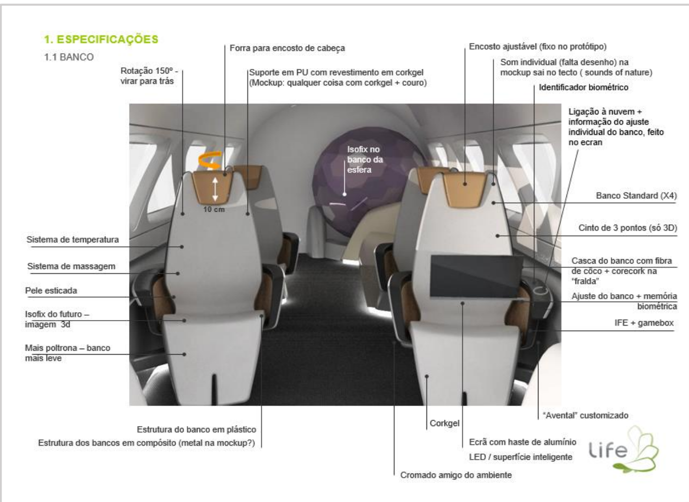


Figure 184 : Case Study #3: CMF proposal (source: Almadesign archive, 2010)

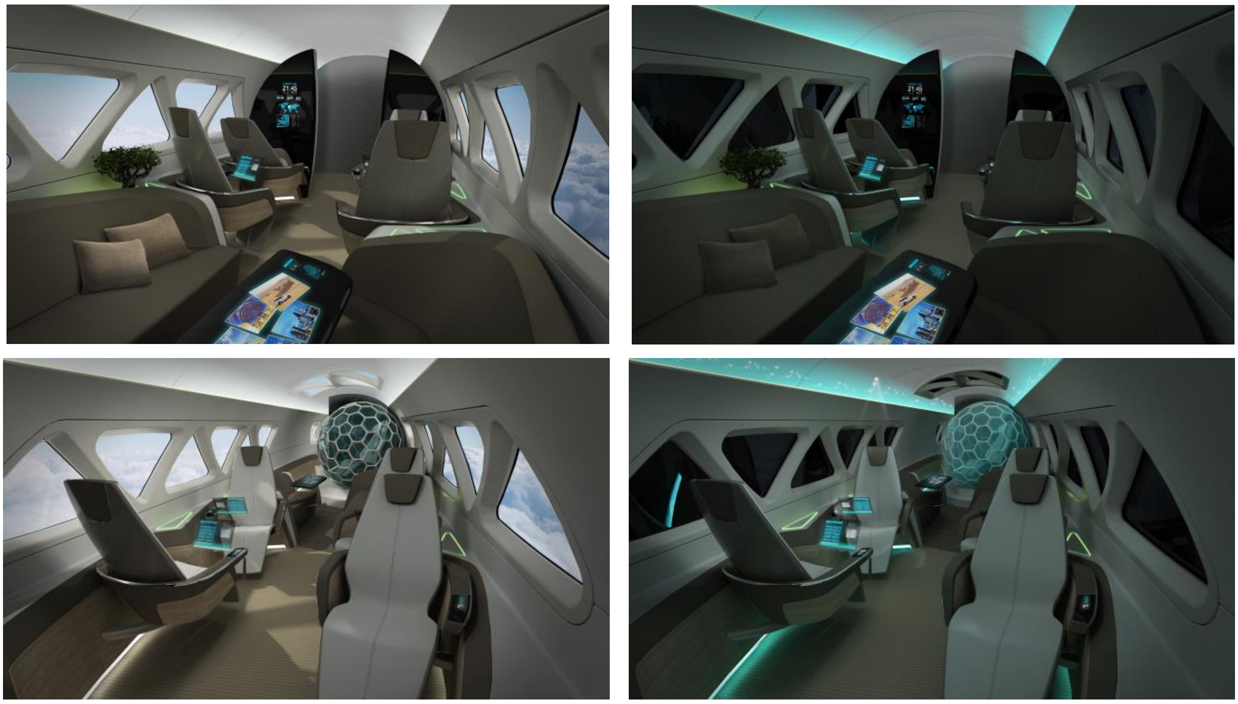


Figure 185 : Case Study #3: CMF rendered proposal- day and night (source: Almadesign archive, 2010)

- EXECUTION:
    - A lot of solutions had to be developed during the prototype build to materialize the form language envisioned by the designers; light elements were used in the side panels, the sphere geometry and building strategy was developed with engineering partners; aluminium parts were built in order to assemble the dodecahedron and assemble it on site; although not fully developed, this element was a central feature in the mock-up, with a seat with specific light details on the inside.
- COMMUNICATION:
    - Not applicable in this project.

2.12.5 FORM SEMANTICS - Symbolic functions (attributed by designers)

- IDEA GENERATION:
    - Definition of 2 concepts / directions for the project: the first direction addressed a rather conservative approach, with a luxury and refinement home / office environment (home in the sky);
    - Concept 2 relied in a nature / technological inspiration, focused in Sci-fi influences (Avatar, Minority report, 2001...), communicating a passenger centered bio-adaptable aircraft interior, combining natural and technological elements; references such as classical design icons - geodesign structures - were used;
    - Concept 2 was an "out-of-the-box" proposal and was chosen by the consortium for development; form language uses complex free form curves, asymmetrical layout, triangular and hexagonal shapes, natural materials and finishes combined with light effects (colored light, light spots) and transparency elements (such as the screens and sphere modules).

- DEVELOPMENT:
  - As the second concept was selected for development and prototype building, designers focused on developing parts which would communicate the futuristic, passenger centric luxury appeal to the concept; this as made by infusing the design with soft, complex curves, natural finishes and high-tech devices such as the sci-fi looking sphere, transparent screens and "sky" ceiling; this were developed to communicate a futuristic vision of luxury, filled with technology with natural materials and finishes, a way to interpret technology human-focused; the main symbolic element is the sphere is the immersive sphere, were the owner of the aircraft could have is office as well as a relaxing / game / work space, by being totally immersed in screens which allow for the projection of alternate realities (such as images of outside the aircraft and flying effect) or information.
- EXECUTION:
  - Most of the conceptual and developed 3D geometries, shapes and materials were possible to introduce in the prototype albeit no full functional; nevertheless, the full scale mock-up was able to communicate high levels of technology seamlessly integrated in a luxury natural material finished cabin interior; the mix of complex, organic curves and with high-tech devices and typical "technological" shapes such as the sphere, created the "illusion".
- COMUNICATION:
  - The project featured 2 presentations VIDEOS: a teaser, with nature elements and the concept of a "tree of LIFE" and a final presentation VIDEO portraying the vision of the future of travelling and aviation;
  - Project brochures were developed in different phases (teaser and final presentation); project presentation included a full scale 8m long aircraft fuselage with full cabin interior.

2.12.6 FORM SEMANTICS - Symbolic functions (perceived by clients)

- IDEA GENERATION AND DEVELOPMENT:
  - The sphere became the major icon of the aircraft concept with a lot of people asking / wondering what is was about; because of the geodesic shapes being actually very present in the popular culture and sci-fi imaginary, most visitors would related it to a high-tech element; being transparent it also gathered a halo of novelty and mystery; the screens and projections (most of them blue in the pictures) also added a look of futurism into the concept, as well as the floating seats and colored lighting scenarios, including the ceiling with a "night sky" effect.
- EXECUTION:
  - A great percentage of clients / partners (100%) think the design is: INNOVATIVE, FUTURISTIC, SOPHISTICATED; 90% think the design is COMPLEX, LIGHTWEIGHT, WARM;
  - A big percentage (70% to 90%) also thinks it communicates: EMOTIONAL, DYNAMIC, FLUID, ORGANIC, FRIENDLY, TRANSPARENT
  -

- COMMUNICATION:
    - Form language, a mix of nature inspiration and high-tech, dynamic and precise lines, together with the choice of materials, featured a futuristic vision of aviation; Photo sessions and post-production conveyed a sense of futurism to the project, combined with the lighting effects (fiber optic "star constellation" ceiling, transparent screens, self-illuminating sphere, sunset behind triangular windows, floating seats, colored light from below);
    - Some “myths” arose regarding the sphere and its function, as well as the Lavatory which due to having a window was confused for a cockpit;
    - In terms of denotation, there were also comments about the way the consortium was addressing sustainability, by developing an aircraft for the “very rich”.

2.13 ***Case Study #3 - Discussion***

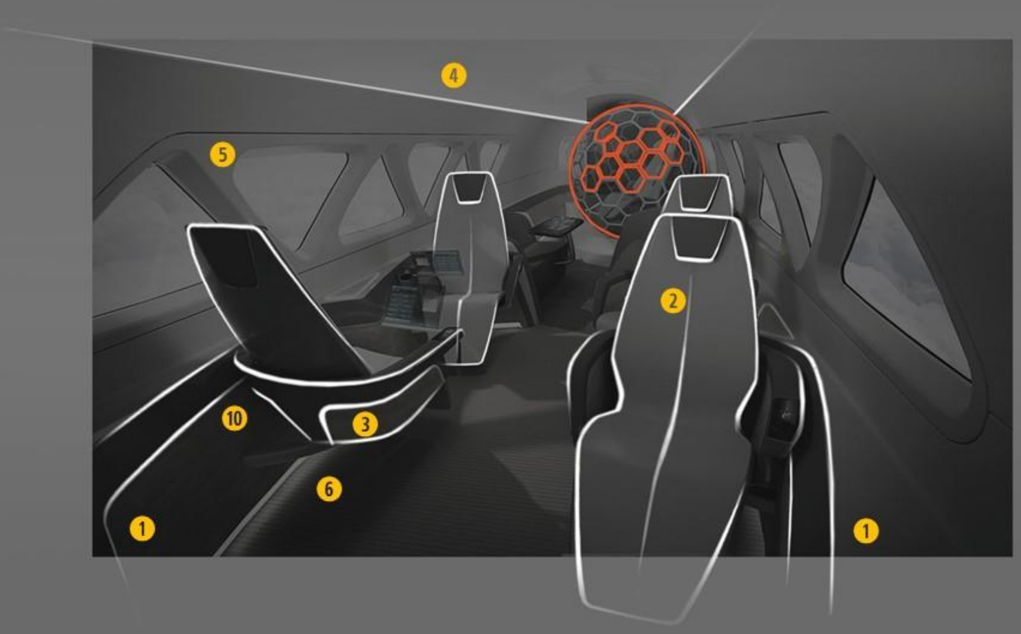
LIFE project was one of the most complex projects for Almadesign at the time. A 2-year R&D effort with 6 companies, it involved not only designers but other specialists from different areas, requiring a significant effort in project management, besides all the creative and technical design activities. Being an R&D "future" project, designers had more "liberty" to explore concepts with less technical restrictions (no certification for airworthiness, the kind every airline or general aviation aircraft needs to be allowed to fly, was needed). The "futuristic" theme was inspired by Sci-fi movies and Nature themes, together with the incorporation of technological innovations. Nevertheless, a mock-up (scale 1:1) was built, which means all the concepts had to be materialized in a physical prototype, which by itself presented a lot of challenges to the designers and their concept design. Different processes and methodologies were used, from brainstorm sessions, preliminary specifications, moodboards, sketching, 3D modelling, scale model making, rendering, prototype building, mock-up assembly and project dissemination. Specific design elements (form language, shapes, cross sections, functions, CMF, light use, etcetera) are identifiable and consistently used throughout the project. LIFE became a reference project for Almadesign and was largely published in international magazines and website, and as a promoting effort of the Portuguese aviation sector. The dissemination documents reference the different ways it was an innovative project:

> *"LIFE is the materialization of a conceptual vision for the future business aircraft, using natural materials. The interior design was developed for productivity (business) - with an executive area followed by a space lounge / meeting - and privacy (personal use), equipped with a bathroom, a bedroom and a sphere with an immersive interactive infotainment system. The different areas are unified through a formal language inspired by organic structures in a symbiosis between natural and artificial elements providing a harmonious environment where technology is present but not imposed. The solutions developed in LIFE are oriented towards the use of lighter, comfortable and natural materials. The innovative window design allows greater visibility and abundant natural light. The environment appeals to the five senses, through textures, chromatic details, aromas, lighting and temperature (…) Floating on a suspended structure in carbon fiber, the seat enhances passenger comfort by reducing the vibration. (…) Interactivity is made possible by an immersive infotainment system. This system consists of a geodesic sphere built in modules that allow the projection of images creating an immersive virtual environment for business or entertainment" (Marcelino, 2012)*

As with the previous two chapters, Case Study #3 was developed using the same framework – spreadsheet and drawings – to isolate constant elements in the Form Language of the projects. Figures 186 to 189 describe the main Form Syntax Elements for the project, as well as their organization and also some notes on Form Semantics, according to the researcher. The following objectives were set and partially achieved, for Case Study #3:

- To analyze LIFE project in different dimensions: projects' Context, Form Syntax and Form Semantics – Just as in the previous projects, it is believed this objective was achieved through the information included in the spreadsheet and in the chapter's text.
- To cross the information on the 3 research vectors with the project's different phases: Research, Concept Design, Design Development, Prototyping, Communication – This objective was achieved through the organization of the framework spreadsheet, which crosses the information between each project phase and each investigation vector.
- To analyze the collect information and try to establish patterns, isolate constants, uncover differences – This analysis is presented in the next pages, through drawings developed by the researcher (Figure 186 to 189); the drawings cover the analysis of both Form Syntax elements, their organization and also Form Semantics from the perspective of the researcher (comments on the images) and according to clients and partners (Figure 189, with keywords).

Figure 186 : Case Study #3: Syntax and Semantics analysis (source: researcher, 2017)



1. Overall contour is fluid, connecting all elements with a “waist line” side contour
2. Seat pans have a gentle curved central element, an anthropomorphic “spine” toped with a “head” support
3. Seat pan is supported by a floating “shell” like armrest structure that wraps around the seat
4. Ceiling is built using a spacer fabric which reproduces a “honeycomb” texture and light dots
5. Windows have a triangular curved alternating pattern
6. Elements are “lifted” from the floor creating a feeling of “lightness”
7. Triangular, hexagonal and pentagonal shapes are recurring and create unity and variety
8. The “honeycomb” sphere provides the central element of the design: “naturetech”
9. Floor and side panels (textile and cork) offer a rich natural texture contrasting to the glossy high-tech screens
10. Color, materials and finish add to visual continuity of design elements: floor, side panels, windows, ceiling

Figure 187 : Case Study #3: Syntax and Semantics analysis (source: researcher, 2017)

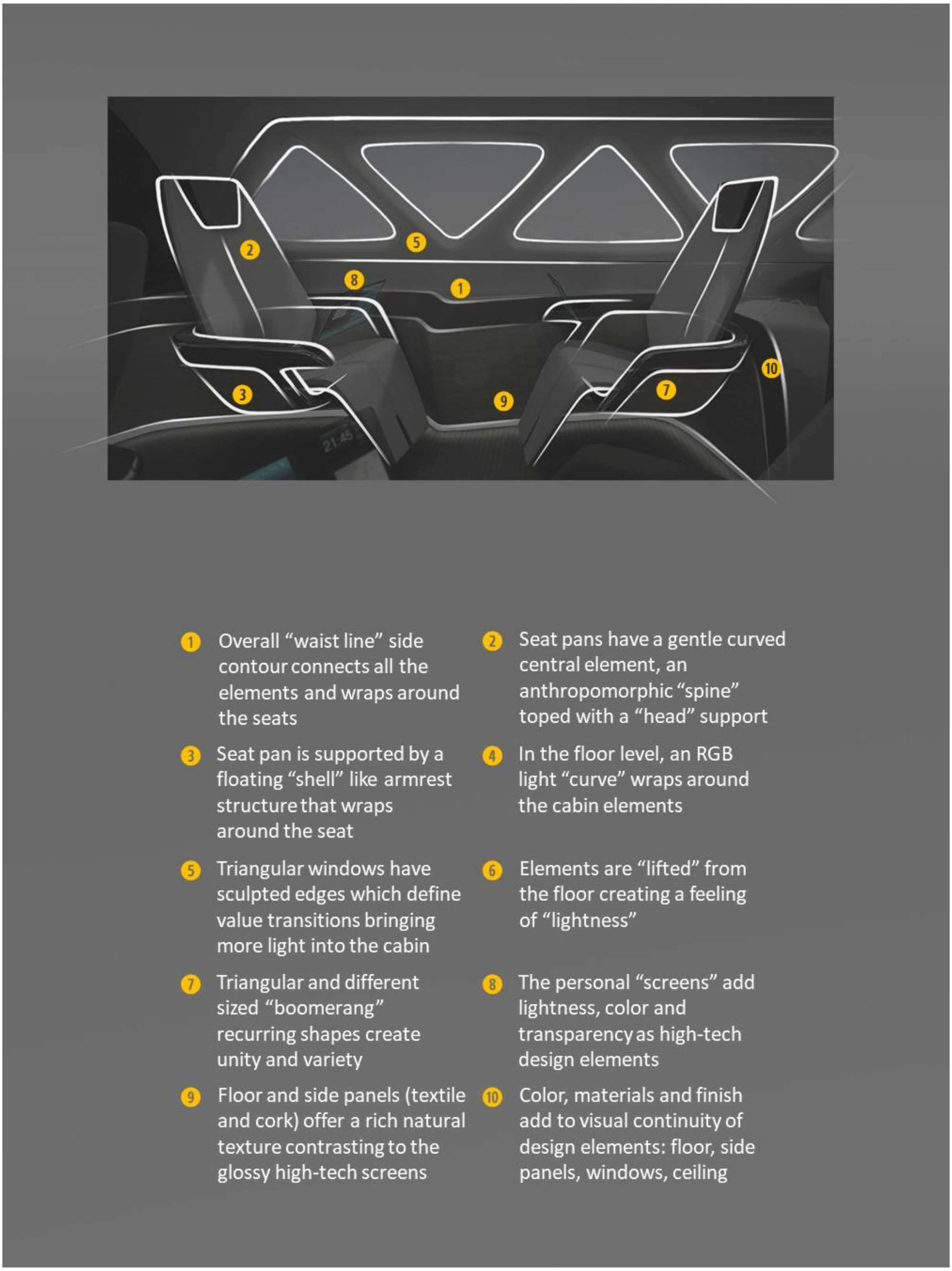


Figure 188 : Case Study #3: Syntax and Semantics analysis (source: researcher, 2017)

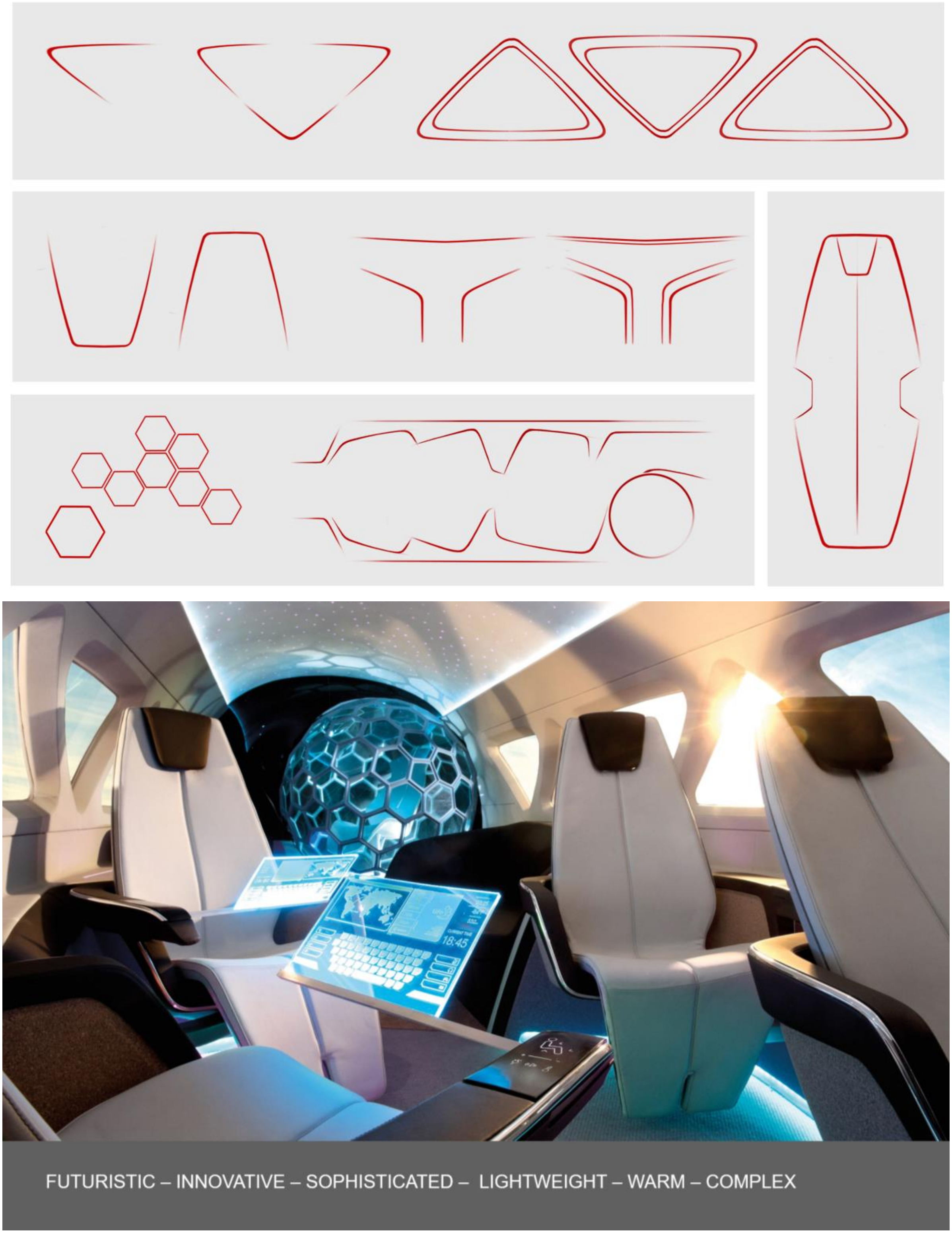


Figure 189 : Main keywords referenced by clients/partners (source: Almadesign, researcher, 2017)

Figure 189 brings together the main Form Syntax elements used in the project using an analytical approach. As with previous Case Studies some of the most relevant form elements from the project according to the researcher were chosen and organized as shown. Just as with the previous Case Study, if we observe from the left to the right, it is possible to see how specific elements such as the “V” shapes, “boomerang” shapes and “tensioned curves” are used and combined in a variety of sizes, scales and combinations. Again, by using these design elements and organizing them with specific design principles – symmetry, repetition, variety, proportion, harmony, unity – the result is larger than the sum of parts. Some of the elements are used throughout the aircraft cabin, from the “cross section” elements to the side panels, windows and seats. Side panels are relevant as they follow a continuous flowing line, which dynamically contours the seats. The seats – which functionally rotate – are nested in the side panels and are themselves contoured by a chromed line which creates a unified whole with the side panels. The cabin layout is asymmetrical, providing even more variety, although a lot of form elements are repeated at different scales providing a harmonious sum of parts. The immersive sphere is in itself built upon the repetition of form elements (pentagons and hexagons with slightly curved sides) and the windows are built around the polar repetition of boomerang shapes, curved in different direction due to the fuselage cross-section.

As with the inTRAIN project, the LIFE project CMF (color, material and finish) represent a fundamental asset in the project, as they bring the warmth and natural materials “look and feel” to the environment. By using textured cork in the side panels, a rich textured carpet flooring, a 3D fabric celling with fiber optic light dots and natural leather seat covers, the project is very rich in complex details and textures. Together with a color scheme which highlights shapes through a clear contrast of materials (light grey, dark brown) and the use of colored light (e.g. passenger screens and RGB light in the lower part of the side panels and top triangular shapes) the project communicates a futuristic, warm and complex “look and feel”. Color and finish also separate and highlight the different functional areas (e.g. seta pan and floating seat structure). Together with the form elements, CMF brings together a Form Language which clients and partners characterize as Futuristic, Innovative, Sophisticated, Lightweight, Warm and Complex.

2.14 ***Case Studies: design format analysis***

The Case studies enabled the researcher to compare three of the most relevant studio projects by using a common framework of analysis. Regarding the three research vectors – Context, Syntax and Semantics, we can conclude that the studio's methodologies play a very important role in the way form language is developed, in sequencial iterations together with designers, clients and partners. The main Form Syntax elements were gathered by the researcher in the drawings presented, but it was found that a general view of the three projects Syntax was important to get a clear view of the design elements and the way they are organized through design principles.

In order to do so, a methodology of Design Format Analysis, after Warrell (2001), was applied to the Case Studies. By bringing the drawings developed together and by characterizing the main Syntax elements, the methodology allowed for a description of the most common used elements in each of the projects using the following scale: black filled DOT (elements are very strong); black contour DOT (elements are strong); no DOT (elements are not present). The following Syntax elements were selected for the analysis:

- Boomerang shapes
- "V" Shapes
- "C" Shapes
- Triangular shapes
- Arrow shapes
- Continuity line
- High contrast elements (graphics)
- Nature / Anthropomorfic / Zoomorphic elements
- Geometric patterns
- Lightweight "look and feel"

The results can be seen in Figure 190 (larger size table in the Anexxes), which highlights the strongest elements (totals in the orange lines) and the strongest presence of the elements in each project (totals in the columns under each project). The most common elements found in the analysis, which we can state are the most important Syntax elements in the Case Studies were:

- Boomerang Shapes (used as metaphors for speed and dynamism)
- Continuity lines (used a a tool to bring together all the elements in the product)
- Nature / Antropomorphic elements (used to infuse personality to the product)

We can also see that the project in which the most relevant elements appear is LIFE project, interestingly eneough the most awarded project of the Studio, which we could state defined a certain Form Language which designers, clients and partners associate with the studio.

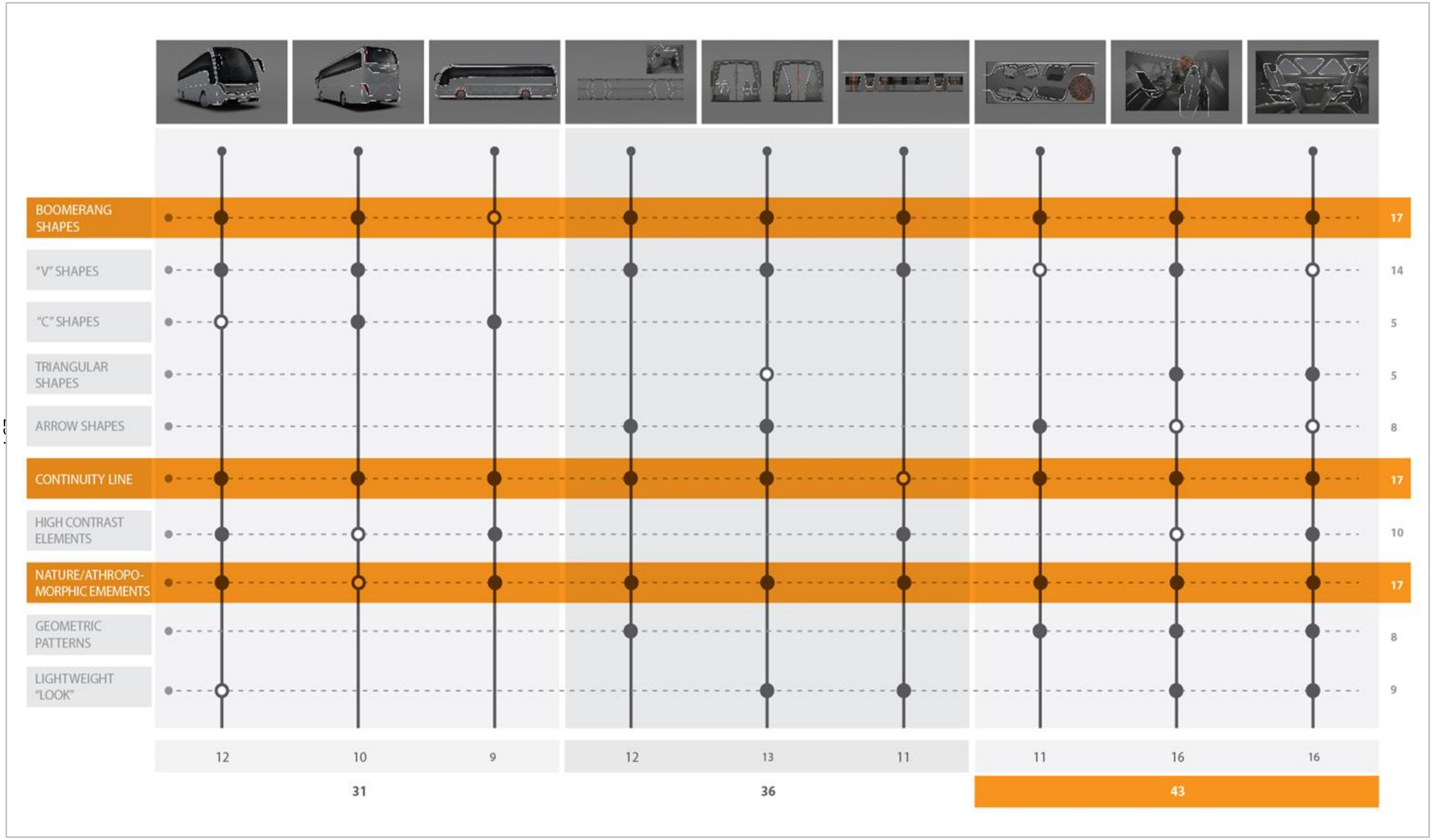


Figure 190 : Case Studies Design Format Analysis, after Warrell (2001) (source: researcher, 2017)

PART V – CONCLUSIONS

PART V: CONCLUSIONS

Overview

The aim of Part V – Conclusions is to summarize the results of this investigation, trying to answer the investigation questions, and referring to contribution the research has provided. It is developed using text and also an infographic chart which summarizes a proposal for Almadesign's Form Language model. A set of drawings was also prepared to achieve an historical summary on the evolution of the studio's form language using as Case Study the most important coach designed and developed, the Winner. Finally, a set of future recommendations is developed.

1 Conclusions

1.1 *Introduction*

Going back some years ago to the start of the research process, the main objectives and questions set by the researcher (himself a designer at Almadesign studio for the last 16 years) were developed to study the Almadesign Studio Form Language. The main question was to prove if the studio designers - in two decades of design projects – had developed a specific Form Language. The main investigation question was whether it would be possible to identify a Form Language and, if so, how it could be studied and characterized. To answer this question, 3 investigation vectors were defined:

- **Context:** analyzing the evolution of the company's Form Language from the perspective of internal and external contexts, including social, economic and technological changes;
- **Form syntax:** characterizing the evolution of the company's Form Language, from the perspective of its syntax (design elements and their organization in design principles);
- **Form semantics:** characterizing the evolution of the company's Form Language in the creation of symbolic meaning from the perspective of clients and/or end-users and how they interpret / transform its meaning.

1.1.1 Objectives

The following objectives were set for this chapter:

- To gather conclusions from all chapters and compile them into a cohesive whole to tentatively answer the Investigation Questions – General findings;
- To cross the information collected from literature review, Experimental Studies and Case studies and identify relations between the studio's Form Language in the light of the three investigation vectors: Context, Form Syntax and Form Semantics;
- To develop an infographic diagram to visualize the most important conclusions and provide a general overview of the whole investigation results – a model for Almadesign Form Language.

1.1.2 Methodology

The information presented in this chapter was developed during the final months of the investigation. The following methodology was used to gather and analyze information for this chapter:

- **General Findings:** Gather conclusions and answer the Investigation Questions;
- **Conclusions:** Discuss findings and organize them in the three investigation vectors – Context, Form Syntax, Form Semantics, trying to establish patterns, isolate constants, etc.
- **Model for Almadesign Form Language:** Create an infographic diagram with the most relevant information and conclusions.

1.2 *General findings*

During the investigation process, the researcher employed a series of different methodologies, both theoretical and empirical in order to tackle the challenge of characterizing the form language of Almadesign studio: Literature Review on the three investigation vectors, Experimental studies with design students, Experimental studies with professional designers, Experimental studies with studio's clients / partners and Case Studies, applied to three of the most relevant studio projects: WINNER coach, inTRAIN project and LIFE project. Altogether, these methodologies allowed the researcher to map the main aspects of the studio's Form Language, characterize its features and define a model which can be used to visualize the process which goes into developing the Form Language. We will briefly outline the main findings for each of the activities developed in the following pages. This will enable us to gather conclusions from previous chapters and compile them into a cohesive whole, which we named the research General Findings.

Throughout the investigation process, the methodology and investigation design was iterative just as in a standard product development design process. This was due to many factors, most of which have to do with the need to constantly adapt the methodologies to the new findings but also to the available resources at each stage of the process. As a professional designer one learns the "hard way" that the first time you try to do something you will not succeed. Nevertheless with this investigation it is considered that all different methodologies contributed to a smooth ascending "learning curve" which led to the final result. A clear preference for practical, empirical methods was preferred, since as designers, the researcher and supervisors take a "hands on approach" into problem solving, which means the process is rationally led by empirical investigation and supported by a theoretical one (and not the other way around). This can be seen as a disadvantage nevertheless, it was the path chosen, and as the empirical activities started the clearer the next steps of the research became.

There is an inherent biased approach towards the investigation, as the researcher is himself a member of the design team and a partner at Almadesign and one of the supervisors is the CEO of the studio (the other supervisor is a design researcher and design professional not related to the studio). By being involved in both the Studio - with a clear focus on a Market and Business approach- and at the Academia - where the researcher teaches (and learns) with the new generation of designers – this investigation is actively trying to bridge both worlds by bringing cross-pollination. Design as any other activity is constantly evolving and so are methodologies at the Studio – where one gets to experience the latest trends in business models and industry breakthroughs - and at the Academia - where one can try different teaching methodologies and learn with the next generation of designer, keeping up to date on both worlds.

In the search for the characterization of Almadesign Form Language, it was decided early on to focus on three different investigation vectors, which could map the whole design process in the studio: Context, Form Syntax and Form Semantics. These three vectors helped creating the foundation for the Form Language study (Context) and establish the way design elements are created and combined (Form Syntax) and how they are perceived (Form Semantics).

1.2.1 Almadesign history

On developing the Almadesign history chapter, one can look at the evolution – starting, growing, investing in knowledge and transferring it to market. A partner of the studio said, referring to the 20 years of work developed at Almadesign in the 2017 Commemorative Book that “it is a timely reminder of how much we take from granted as we see, captured in one document, the years of knowledge and skill it takes to build and retain the team of creative adventurers that make Alma”. This reference is of course very flattering for everyone at the studio, but it does remind us that a lot has happened: designers changed, methodologies evolved, skills improved over the years, experience was gained, and thousands of hours of work were put in projects. During all this process one thing remained the same: Rui Marcelino has been the leader since day one and his strong leadership, organizational process and exceptional design culture is a reference to everyone who has worked at the studio. During twenty years the methodology of project development has been incrementally improved, with no major “breakthroughs” but with a steady, climbing learning curve. Over the years the methodologies have been refined and improved, with new creative tools, software tools and management tools learned and reinforced over the years. More than twelve R&D consortium projects were developed since 2007, which means the studio and its teams have developed an active experience in working with multidisciplinary teams and have learned the ability to manage, create and develop new products with specialists from different areas. This is the foundation in which the Form Language of the studio has developed over the years and which have granted Almadesign several National and International awards form its peers.

1.2.2 Form Language in Design History

When reviewing the Form Language in design history, the research team was reminded of so many references which ground the knowledge of the past design activities in order to transform, rebuild, and combine it into new concepts, hybridizations and new solutions. Being such a vast field of influences, it was decided to use an empirical approach – Experimental Study #2 – in order to define the most important periods of design history to include in the review. The twentieth century saw the emergency of the industrial design profession with the US and Italy to have a fundamental role in positioning it in the market (specifically transport designers). Design professionals were able to developed producing products and solutions that hopefully helped shape better societies: improve mobility, improve access to information, equality and accessibility; democratize travel, improve access to both individual and public mobility systems. Of course all these products and solutions carry a footprint which designers are also responsible for, and sometimes they helped shape consumer societies based on obsolescence. Looking back at history, this chapter made it clear for the research that it is fundamentally important to see how the designer is a mediator between people and technology, and has hence had the opportunity to change people’s life, hopefully for the better in most cases. The difficult balance between new technologies and societal changes becomes quite clear in this chapter, which led to the brief references to an immense body of knowledge which was only barely investigated. The research nevertheless underlined the connection between the historical period, the art movement, the societal changes, the technologies involved and a specific (Design) Form Language. From Art Nouveau, Arts and Crafts, the Modernist movement, Streamlining, to the

Jet age, Organic design or Post-modernism, the historical periods have had an immense impact on the products we use and helped shape the societies we have lived in. For some of the studio's designers, born in the 70's and 80's, the jet age is still a reference as an optimistic Era of technology and the improvement of people's lives. From the different styles and approaches, the studio's designers chose a handful of interesting examples during Experimental Study #2, bringing some of the most relevant designs ever made into play and discussion.

1.2.3 Form Syntax

Regarding Form Syntax, the field of knowledge is just immense and overwhelming but fundamental for this research. The process through which the designers develop a Form Language in a product - its Form elements and organization through Design Principles - include a series of aspects which take years to develop by professional designers. The Gestalt principles are still a valid reference in the way psychologists studied our visual perception, nature principles and analogies are priceless tools for designers, some found to have a universal appeal (such as the baby face bias or anthropomorphism). Over the years, the subtle connection between nature analogies and technological elements has created a Form Language at the studio which resulted in awarded projects such as inTRAIN or LIFE project.

The Form Syntax principles described in the literature review were then used to analyze specific studio projects. This research approach intended to understand the process by which the studio's Form Language is materialized and learn from it. As with all processes of deconstruction and analysis, this is quite the opposite process of developing the product in the first place where a designer wants to achieve a holistic, global approach (synthesis and not analysis). But an "atomistic" approach can be very important as a learning tool, analyzing separately each design element and the way it is connected to others and organized through design principles. Analog to the way musicians practice "scales", designers can build a library of solutions by looking at the separate elements and analyzing their organization, improving their knowledge and library of solution to synthetize concepts through sketches, 3Dmodels and prototypes in an integrated, holistic way.

Form Syntax can be directly related to the way our brain perceives visual elements. The chapter describes briefly such concepts as the "Primary" (reptilian) brain - visceral and in which the rules of gestalt and visual order are paramount; "Behavioural" – rational and where functionalism becomes more important resulting from the interaction with the product; "Reflective" – intellectualized, where social, cultural and "taste" are fundamental in judging a design as well as connotations and denotations, analogies, myths and other stories are developed.

Almadesign Form Language includes Nature's principles such as the use of anthropomorphic forms (e.g. the review mirrors form WINNER buses, the "human figure" shaped seats in LIFE project or the "leaf like" roof central element in inTRAIN project). Similarity and repetition are used throughout many projects in elements such as the triangles and hexagons in LIFE project, or the boomerang shape in WINNER and inTRAIN projects. Different types of Signs are used in communicating the design intent, some Iconic (such as the brand logotypes), some Indexial (speed metaphors such as the portrayal of "arrow" or "boomerang" shapes which are associated with symbols of speed) and some Symbolic (as in the case of the LIFE luxury interior, which communicates its high-end target customer through the use of refined materials and finishes in a high-tech but nature inspired Form Language environment).

1.2.4 Form Semantics

When addressing issues of Form Semantics we can refer to modernist paradox as represented by Braun and Dieter Rams. Even by “not addressing” the communicative role of the designs, and worrying only about form following function, their work eventually created an array of different communicative references. The fact that users themselves built upon the design and create their own meaning through product use is an essential part of the equation and if not addressed it can lead to misinterpretations. This research considers it is important to explore the communicative approach, which can lead to human-centered products, but also because it can bring pleasant emotions to its users, by being functional, aesthetically pleasing and thought provoking, through symbolic communication. This is ever more important when the creation of user-interfaces and experiences is a focal point in the work of designers, and these have to be decoded and semantically interpreted.

In the process of the research, several communication models are shown, starting from the product language functions developed by the Ulm school and going through several other models which account for the psychological responses to product design. The chapter concludes that meaning is always co-determined by the users and that the cultural context is fundamental for the perception of product style and Form Language.

1.2.5 Experimental Study #1

Visual recognition of products has become a central competitive factor within various product categories and companies must develop products with designs that not only appear attractive but also carry distinctive references to the ‘character’ of the brand, manifest in defined core values (Karjalainen, 2007). The first Experimental Study tried to explore the Semantics of the Studio’s Form Language by comparing it to other consultancies. Named “Reverse inspiration: analysis of Form Language in design studios” by analogy with “reverse engineering” methodologies, students deconstructed the creation process by identifying possible inspirational references which led to the project’s Form Language. Results helped the researcher to validate the investigation question, identifying specific, unique references to the studio’s Form Language.

Research found that is there is a correlation between specific Almadesign projects and references to both “NATURE” concepts and “SCI-FI” (futuristic) themes. These connection to these themes were much higher than on any of the other selected projects from competitor consultancies. These preliminary conclusions may be related to the fact that the Almadesign projects selected were R&D projects, meaning they were developed as prototypes (virtual and/or physical) but were not actually manufactured in large scale. This fact can account for the fact that the designers had a lot more freedom to design “want they wanted” not being too restrained by manufacturing and certification issues. Nevertheless, this also happened in some of the competitors' projects (5 overall) which means all companies stood on the same "playfield".

We can argue that the results underline a certain validity in the hypothesis, in which we state that we can identify and characterize the Form Language of the studio and that it references specific NATURE concepts which portray a FUTURISTIC vision of the future, sometimes influenced by SCI-FI elements. The exercise contributed to this research but also to educational purposes (the "reverse inspiration" methodology" helped students gain competencies and generated insightful quantitative and qualitative data concerning the design style of the consultancies selected).

1.2.6 Experimental Study #2

Experimental Study #2 was one of the most interesting empirical activities developed during the research as it involved not only current but also ex-studio designers and in which most of them really appreciated the exercise. They were called to make a reflection upon their own path as designers and the (difficult) choice of deciding which the most important Form Language references in each category was. By choosing and characterizing their Form Language influences in different fields, from transport design to automotive, product fashion, architecture, art, nature, and future, designers were able to share their culture and discuss their influences, major inspirations and ultimately provide reasons for taking certain design decisions.

Main conclusions were that Designers differ in age groups, work experience at Almadesign, gender, etcetera, but also show a lot of common trends, with several choices repeated as well as keywords to describe the choices. Transport design choices feature speed metaphors, "nature" inspired design and technology overstated by design. Automotive design choices feature words such as "sensual" "emotive" and "aggressive"; on the other hand, this category also features words such as "cute", referring to friendly designs with baby-face bias. Architecture references tend to be highly formalist, "iconic", "dynamic" and "nature" inspired. Product design choices tend towards a more conservative approach, specifically a technological "minimalistic" style on electronic products; furniture choices tended to be more emotional and organic / nature inspired. Cinema references focused predominantly in Sci-fi movies, featuring iconic designs, bright elegant speed metaphors or, on the other hand, dark and dystopian views. Trends for future design focus on dialectics between "nature and technology", "human and machine", from engineered sustainable choices to automated, generative designs using smart materials and technologies.

Overall words which are more frequently used include: Futuristic, Organic (also Technological, Functional, Minimal, Transparent, Timeless, Detailed, Dynamic, etcetera); these words were used further on to support the development of the Survey, for Almadesign clients and partners (Experimental Study #3). The concept of re-use and repetition of known formats reimagined helps in bringing the element of familiarity (prototypically) but interpreted in a different way which will help users get emotional and feel something about the design.

1.2.7 Experimental Study #3

Experimental Study #3 was the study made with clients and partners and in which it was tentatively proved that clients and partners would decode the meanings imbedded in the products by the designers. Although a different approach had been devised in the beginning of this process, in the end a survey online was made to 20 of the most relevant clients and partners. These were professionals with a very long experience, most of them with more than 15 to 20 years in the field of management, engineering and product development.

As a general conclusion, we can state that certain features are clearly perceived by clients and partners as Semantic attributes of Almadesign Visual Language. The main features (more than 70% of the answers in all 3 projects) are that Almadesign projects (the ones referred to in the survey and also the Case Studies, that is Project WINNER, LIFE and inTRAIN) are considered Innovative, Sophisticated, Futuristic, Dynamic, Fluid, Friendly. Certain features are not that clearly communicated, which could be due to the questions being badly formulated or as different individuals have different interpretations of written words and visual features. This issues between “words and products” (by analogy with Adrian Forty’s book “Words and Buildings”) is something which brought a biased result due to the process through which the study was conducted. The main problem was in the adjectives that repeatedly throughout the 3 projects are voted “one” or its “opposite” and which feature most likely badly formulated questions, as they are opened to very different interpretations. These are mainly the following pairs of adjectives: Organic vs Geometric; Urban vs Cosy.

Nevertheless some interesting results were found, besides the main adjectives which were used to identify Almadesign Form Language. It was also important to check what Almadesign Form Language was considered NOT to be, and this was: Conventional; Standard; Traditional; Static; Massive; Aggressive. Finally, the clients and partners associated the studio with the following automotive brands: Alfa Romeo, BMW, Ferrari: brands associated with design, sportiness, dynamics but also sport friendly (Mini Cooper); Citroen or Range Rover: which were associated robustness, practicality and innovation: For this brands, clients and partners mentioned specific adjectives are mentioned and confirm the survey questions results: Innovation; Sophistication; Dynamic; Visionary.

1.2.8 Case Studies

When moving to the Case Studies a big difficulty arose in that there was so much information about the three different projects at Almadesign. The biggest challenge was to choose the most important information to present it, analyze it and discuss the results in an operative, efficient way. This was made possible via a framework developed by the researcher in which a spreadsheet was used to compile information of the different projects. This information included, drawings, photographs, reports, minutes of meetings, publications, etc. The Framework was descriptive using text to fill in each category, but also descriptive by means of visual communication, with the researcher developing specific drawings which cloud isolate constant elements in the Form Syntax of the projects.

For each of the Case Studies a text was developed for each of the projects phase - Idea generation: planning, research and concept generation; Development: concept development, product engineering; Execution: prototype, production; Communication: promotion, market follow-up - (Marcelino, 2012) – which was then crossed with the information regarding the three different vectors: CONTEXT (Internal: Designers, Resources, Methodologies, Tools, Innovation processes, Tools, market “agreements”, schedule; External: Client’s brief, Social / Economic / Legal, Market / Culture / Inspiration, Tech Trends); FORM SYNTAX (Practical functions: Function / Performance / Composition, Production technologies / constraints, adaptations; Formal/aesthetic functions: Form language / vocabulary, CMF (color, materials and finishing); FORM SEMANTICS (Sign / symbolic functions: designers attribution; clients interpretation).

Main Form Syntax and Semantics results were gathered and summarized in drawings developed by the researcher, with the visualization of the most relevant Form elements and by which we can conclude that there is a specific vocabulary of elements which go from an overall aerodynamic “silhouette”, to “lines” which wrap around products and divided its main functional volumes, tensioned curves which are “metaphors for speed” like the boomerang / arrow shape, carefully balanced “proportions”, line graphics which work as functional elements but also as “motion lines”, recurring shapes in different scales which create “unity, variety and rhythm”, specific cross-section shapes which define form, add visual tone variations, the “anthropomorphizing” of products, the use of “nature shape analogies”, the use of strong contrast in CMF choices which help read the form and determine functional areas.

1.2.9 Investigation questions

The following investigation questions were developed and answered during the investigation:

- “Is it possible to identify and characterize a specific Form Language developed at Almadesign studio?”

The answer is yes, we can. The Form Language is characterized by an evolving Context, a specific Form Syntax developed by the studios’ designers and a specific Form Semantics interpreted by clients and partners. Each of this research vectors can be further explored by trying to answer the three sub-questions proposed.

- “In which Context did the Form Language develop?”

The Context of the Form Language development at the studio evolved over time. To answer the first sub question, we can look at the studio history, when it started as a small 3 designer company with 1 client. In 2017 the studio employed 12 full-time designers and works on dozens of projects every month. It started as a design consultancy for a bus manufacturer which is still a studio client and for whom the studio has designer more than 30 buses and coaches. The studio has been responsible for more than 12 R&D funded projects with several Portuguese and European companies. The studio also developed flag-ship projects in Portugal such as the Alfa Pendular train or the TAP airline cabin interiors, which brought a great deal of new knowledge and experience to the design teams, when dealing with technical constraints, suppliers and OEMs. A strategy of partnerships and R&D efforts brought the company to a successful point in the market, where it is considered by its pears (e.g. is a COTEC council member in Portugal). The studio has also received several awards by its peers, and specifically the Crystal Cabin Award, considered the Oscar of aviation industry for project LIFE in 2012. The company was able to successfully overcome the financial crisis through the managing capabilities focues on an innovation strategy. The evolving context means that ever more complex projects have been developed by the company's designers, using updated tools and methodologies over the years – software tools, creativity tools, prototyping tools, supplier knowledge and partnerships, etcetera - which lead to a form language which is more complex, detailed, complete, including every form, shape, line, material, texture and finish. The connection to the Academia and the R&D projects has kept the interest in developing updates tools and methodologies.

- "How can we define the Form Syntax developed in the design studio?"

In order to define the Form Syntax developed at the studio we can look at the Case Study analysis and isolate constants. The use of speed metaphor shapes, some inspired by nature, other by product and automotive design, such as wedges, "v" shapes, boomerangs, arrows, wings and fins to convey speed and dynamism, the use of recurring shapes in different scales (such as in nature's fractal principles) organized in design principles which create rhythm, unity and variety. The use of nature analogies and strategies to anthropomorphize products and infuse them with Symbolic character. The presence of carefully evolved brand elements, the use of strategic connection elements in order to create visually light elements, the use of natural material finishes, nature inspired color palettes, high contrast materials when defining main volumes and balancing proportions, color as an indicator of functional elements, the use of ever more detailed textures and finishing and a use of colored light in order to communicate different moods. The Form Syntax is inspired by the designer's own visual culture, specifically the founding members who studied and got inspiration from the Jet Age, Automotive design and Nature. The following elements can be highlighted as the most important Form Syntax elements found during this research:

- Speed metaphor shapes: wedges, "v" shapes, boomerangs, arrows, wings
- Visual organization: symmetry, unity and variety, repetition, harmony, proportion
- Nature analogies: anthropomorphic character and natural material finishes & color palettes
- Culture: Jet Age and Automotive inspiration, Nature analogies

It is also very important to mention that Almadesign Form Language is not common to all projects but is a part of a process which is shared and discussed with clients and partners. In fact, as seen in Case Study #1, #2 and #3, Almadesign concept phase typically is addressed using different Form Languages, which create different possibilities for the clients / partners to choose from. From an initial product specification, designers develop concepts which are commonly referred to by specific names (such as in Project INTRAIN, Case Study #2). These names "frame" a specific Form Language in which to develop the product and are typically called:

- NATURE: which typically features natural shape analogies, usually soft curves, flowing surfacing and nature inspired color palettes; sometimes inspired by anthropomorphic analogies;
- DYNAMIC (or TECH): which include direct references to automotive / aviation and high-tech products, with speed metaphors such as “wings”, “boomerangs”, “arrows” and the use of straight and tense curved lines and surfaces;
- URBAN (or MINIMAL): which are grounded in product design references, most of the times minimalistic and using soft curved surfacing and primary shapes as details (such as circles, squares or the combination of both).
- HOME: with simple shapes and an honest use of materials and textures, referring to home-like environments;

These first concepts are normally presented to clients / partners at an early stage of the design process and are then, through successive design meetings – refined into the final product. This means the process is quite participative, and the client / partners have a voting in which Form Language to develop further (sometimes it can be a combination of two or more concepts). This approach stand out as a clearly focused “client-oriented” strategy by the studio, this is to say that designers try to making sure the Form Language is diverse enough to satisfy the client’s brief. Also fundamental in the studio’s strategy is its “quality control” which means the top management always controls the aesthetic decisions made, and actively participates in the designs. This ensures a coherent look and quality over all the designs, albeit possibly inhibiting possible breakthroughs.

- “How is the Form Semantics interpreted by clients/partners?”

With the objective of defining the Form Semantics, we have to look at both sides of the equation: in one side we have the designers, who develop products based on a clients’ brief and try to express different messages through the design; the other is the clients / partners who interpret the design language and sometimes actively participate in the definition of the Form Language direction in design meetings. Individual designers are influenced by their own visual culture, but the studio cultivates a process by which several designers develop concepts and the top management oversees the creative process. The studio typically defines 3 to 4 concepts for each project and presents them in design meetings where clients / partners actively take part of the decision of which form language to pursuit. In two of the Case Studies, inTRAIN project and LIFE Project, the nature and technological approach was mostly favored, in a mix of fluid shapes, natural materials and technological elements. Nevertheless, we could argue that even in the remaining concepts presented to the clients / partners and not chosen to further develop, a determined set of design elements and even more important, its organization into a coherent whole was present. In the cases studied, clients and partners found the Form Semantics to communicate “Innovative”, “Sophisticated”, “Futuristic”, “Dynamic”, “Fluid” and “Friendly” designs.

Overall, during the study, some words and references were repeated by both students, designers and clients / partners in the various empirical studies. In fact, adjectives such as Technological, Futuristic (Sci-Fi) or Natural, which appear in all 3 Experimental Studies bring the focus to the theme of the designer as the mediator between people and technology providing a vision of the future (both near

– with products for the market - and long-term future – with conceptual visions). Almadesign studio Form Language also carries an emotional appeal, as referred to by studio designers, clients and partners, which referred to the studio and associate the Form Language with automotive sportive and dynamic brands, with sophistication, innovation and a vision of the future.

We can argue that this “sense of future” present in the studio’s Form Language is grounded on references from nature, from current and past design references, which are reinterpreted and redesigned using new materials and technologies for functional and aesthetic purposes and which, in the final product, help communicate a sense of futurism, wonder and emotion. Going back to the initial figure presented, in which Form, Function and Technology are interconnected, perhaps the missing link is the emotional side of the design, the element which makes one like a design because it stirs his emotions. An this is probably true to the studio’s Form Language, so we can reframe the model (Figure 191):

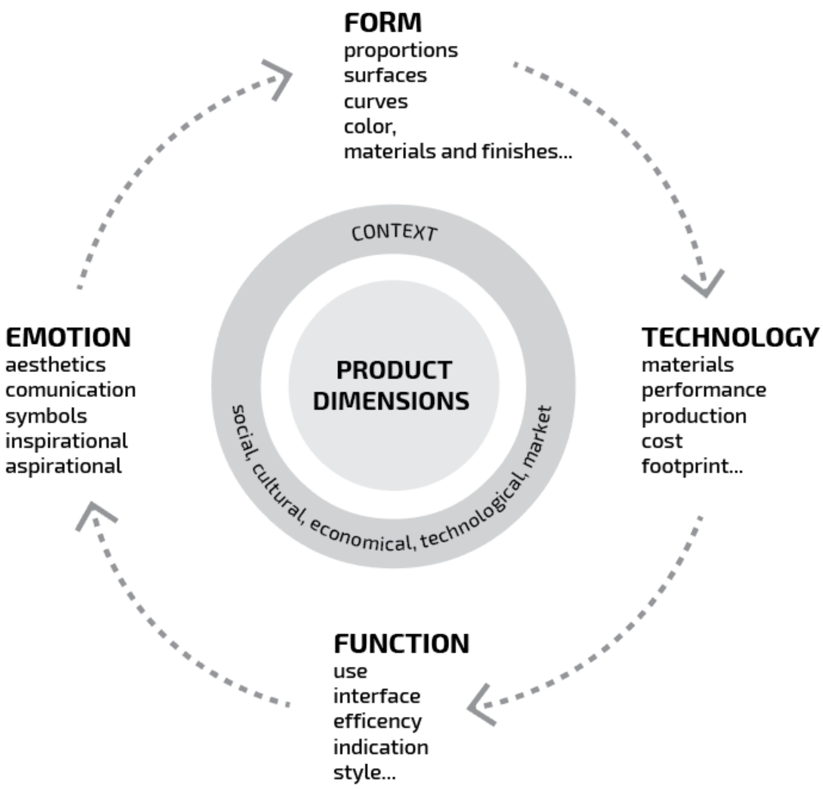


Figure 191 : Product dimensions (source: researcher, 2017)

The approach of “looking into the future” and embracing the love for design is embedded in the studio’s culture since its inception by its management. An almost playful, childish joy can be seen in most of the designers and their love for designing. Based on the transport products developed over the last years, specifically in railway and aviation, we will use the words of Designer Marc Newson in an analogy to Almadesign studio's team love for the playfulness of design:

> *"The most important thing for me was to design (cabin interiors) with new and modern materials, because they look so fantastic. The logic in the past has been to recreate a terrestrial environment in an aircraft – but I think philosophically that's the wrong approach – I love the aircraft, I love flying and I think the processes, technology and materials that have been developed for this industry are wonderful things to play with as designer – they're wonderful tools to have" (Newson, 2008).*

Over the period of 20 years of developing design projects, we can argue that the Form Language of Almadesign has also evolved and is now able to respond to ever complex design challenges. New methodologies and services (such as Brainstorming, Moodboarding, Rapid Prototyping, Color, Materials and Finish services, etc) as well as new digital tools (such as digital painting and software tools such as research and trend tools, simulation and 3D generative tools) have brought the designs to increasingly complex levels. At the same time the prototyping capabilities, tools and technologies are also improving the design process and will eventually influence the development of future Form Languages. It is thus fundamental to address the Context of each moment in time, culturally, socially, technologically and to promote ever more competencies in developing products with a specific Form Syntax which can lead to a clearly interpreted Form Semantics. Steffen (2010) illustrates the importance of a clear communication process:

> *"(…) symbolic innovation requires a clear sighted and holistic sense of current developments and trends as well as interpretation and imagination. In both cases, symbolic innovation provided insight and added new visions. Secondly, they confirm that symbolic innovation enables the designer to position him – or herself actively in the societal, socio-cultural, technological, economic or ecological tendencies and to offer the audience a symbolically transformed embodiment." (Steffen, 2010, apud Vihma, 2010 pp 96).*

Almadesign studio states in its mission to be a "design driven innovation" company developing "human-centered technology solutions". In effect, clients and partners considered the Form Language of the studio to communicate Innovation, Sophistication and a Visionary design into its products. It is important to refer that the studio has had a specific methodology which has evolved over time, to become more flexible and able to respond to ever more complex products and different client's needs (e.g. clients/partners from different cultures and nationalities). Over the years, this methodology has been gradually improved, with the additions of a few steps and different tools, but some of the most important principles are kept constant such as the overall studio organization, the use of initial research tools, brainstorming sessions to frame the problems; sketching as the tool to develop initial ideas – concept drawings; the effort to present different ideas and solutions for the same problem, which are permeable to the client / partner input; the ability to further develop and detail products always looking for technical solutions which will not compromise neither the concept drawing presented, neither the functionality, technology, maintainability; an effort in bringing the project to completion (“the best project is the one which is ready on the delivery date”).

On the future of design practice and particularly on the future of transport design we can argue that an evolution towards dematerialization of the products is already happening. Graphical interfaces and HMI is gaining more and more importance in the automotive design departments. This has, of course, to do with the digitalization of the IP and cockpit in general, with specific steps which could be considered more radical in such models as fully electric, autonomous cars. In the advent of total digitalization, connectivity and autonomous driving, car design will struggle with new challenges. Almadesign, as any design studio, must be able to read the context and adapt its Form Language and design practice accordingly to change. Users will still need to have physical products in which to eat, sleep, socialize and have fun. Transport design will still need to have big infrastructures and vehicles, but a turn into service design instead of product design is already a trend in the quest for a more sustainable society (the industrial designer’s footprint is considerable, particularly for automotive designers). Nevertheless, with the rise of electromobility, autonomous driving, IoT and shared mobility systems, the sustainable future promises to be a very interesting place for designers. New software and prototyping / making tools will enhance the designer’s abilities to early prototype and design ever more complex products, with integrated technologies and using novel materials with new properties. The use of software tools for simulation (CFD, microscopic simulation, etcetera) and for designing (computer aided algorithms) will probably continue to guide the designers in the role of human-technology mediators.

Studio designers commented during Experimental study #2 session, that the ability to help create a better future was one of the main driver of their work, combining technology in a human-centred design practice. We can argue that the studio has already had a share in doing so. During the last 20 years Portugal has been through very different economical cycles, from the years of Expo 98 and Euro 2004, to the finantial crisis of 2008, from a period of growth to a period of degrowth and stagnation with the presence of a bailout programme. The innovation strategy and partnerships over the years have produced a lot of sinergies in the industry and made some of the most important transport design projects possible in Portugal, such as the Alfa Pendular refurbich projetc or the TAP fleet retrofit. These two projects probably account for over 40 million passengers a year combined. In this sense Almadesign has created a new Form Language for transport products in Portugal which are used by millions of passengers every year. Just as architecture and urbanism have had a huge impact in improving the “framework of our lives” specially since the example set by EXPO 98 riverside urban intervention, so has the design work of a lot of professionals in the last 20 years, in which we can include Almadesign studio.

Design can be considered a profession in the crossroads between technology and art. Since its early days, it reflected the need to adapt technology to human needs. This investigation hopes to contribute to the role of the designer in building a better future.

1.3 ***Contribution to knowledge***

1.3.1 A model for Almadesign Form Language

In trying to visualize the most important conclusions of the investigation, the development of a specific Model framing the development of Almadesign studio's Form Language was considered fundamental. Figure 192 presents the Model proposal. It is based on Crilly's (2010) and Bloch's (1995) models of a two-way communication model, in which the designer is the "emitter" of the artefact (the "message") and the client / partner is the "receiver".

Designers carry with them their own experiences, capabilities, motivations and expectations and answer to a specific design brief, many times informed (constructed) by the clients / partners. The designer then intentionally develops a product with certain form elements, which carry meaning in a semantic transformation process (Karjalainen, 2004). The product carries symbols (indices and icons) some of them, by definition, universally understood, some needing a cultural background and specific context to be understood by the clients / partners. The "receiving" group will attribute different meanings to the product according to their own experience, capabilities and personal, cultural and organizational context. Meaning is created in the contact with the product (visual or in use). This contact will happen in different stages of product development, mainly in the Conceptual and Development phases.

In case of Almadesign studio, the clients / partners actively participate in the decision of the Form Language to develop further, and sometimes combine different aspects of several concepts. So, we considered a feedback loop which goes back to the designer who produces a refinement version of the concept. The process is repeated until a final concept refinement proposal – defining the basic setup of Form Language – is accepted. From this stage on, designers will try to develop the concept, many times together with the client / partner technical teams, in order to preserve the most important Form Language features presented during the concept stage. In the end, after all the restrictions, trade-offs and development process, a final product is ready to show and use, carrying with it a specific Form Syntax which will be interpreted by the client / partner and which will probably evolve over the use of the product and the passing of time. For most of Almadesign's projects, this will be the case as the client / partner is part on a system in which a final user is two degrees away from the process. With the case of the bus industry, Almadesign develops the product for the manufacturer (OEM) which will then sell the product to a transport operator (e.g. National Express in the UK). The final user will be a client of National Express.

Figure 192 depicts the Model developed. As referred by Krippendorf and Butter (1984) all communicative analogies for design models are complex and should not be considered "linear", as interpretations vary according to different aspects such as different final users and their involvement with the product. Hence the importance of having a Model, which hopefully can be further used to analyze other Form Languages in other design studios (for a larger size diagram see the Anexxes).

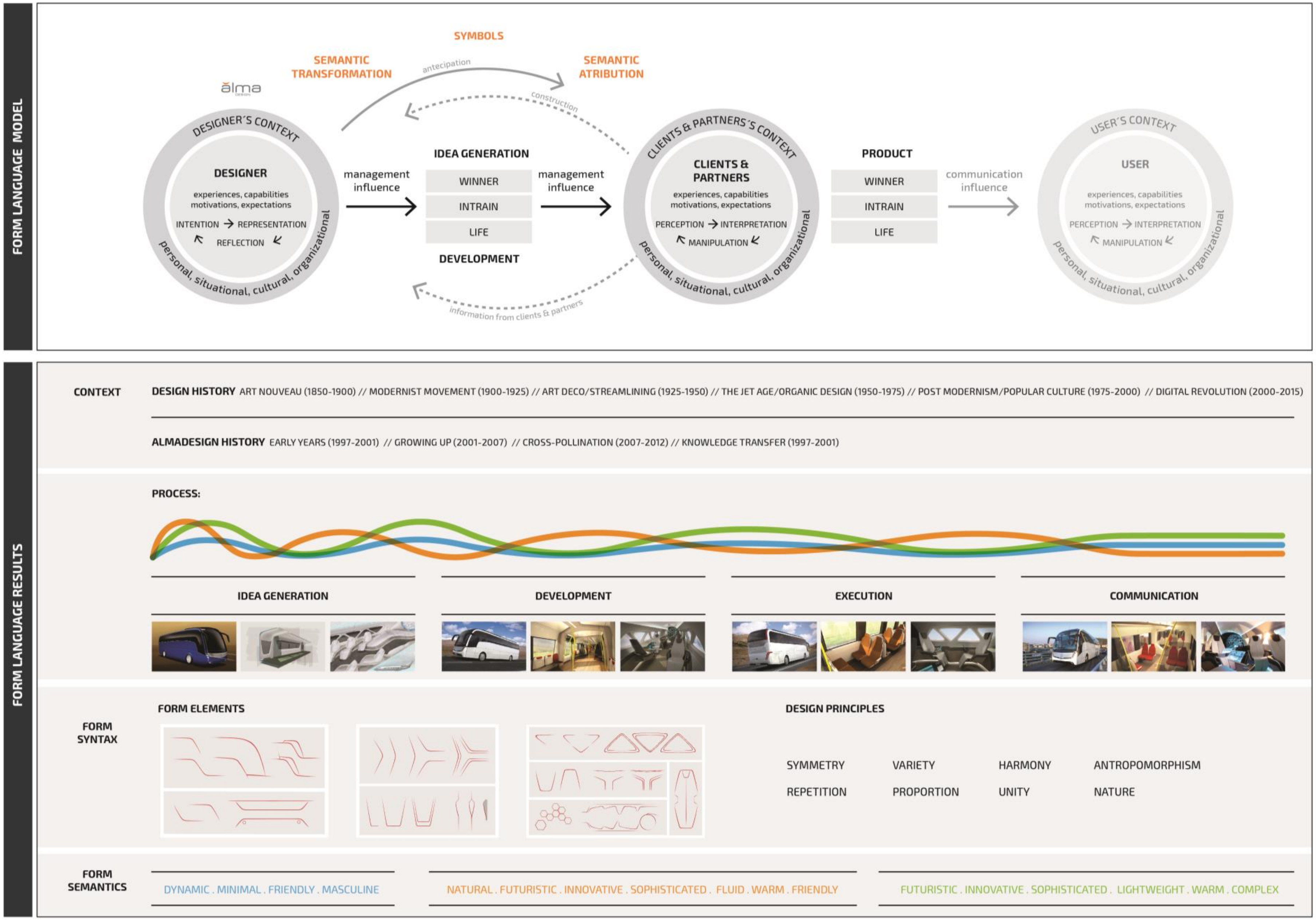


Figure 192 : Almadesign Form Language Model (source: researcher & Catarina Ferreira, 2017)

1.4 ***Further investigation***

1.4.1 Suggestions for further investigation

During the investigation several questions were raised and which require further research. The following are considered the most relevant:

- More Case Studies: it is considered that a thorough analytical analysis of at least 10 Case Studies could be very helpful in further developing the Form Syntax and Form Semantics study. A more thorough, focused approach could also be taken in studying Form Language developments over time. The approach of the research was broad and not specifically focused on this point, but the WINNER Case Study (and the evolution of the Form Language over twenty years) provided valuable data.
- Final users feedback: it would be relevant to collect data and feedback not only from clients and partners but also from final users, particularly on transport products which are used by literally millions of passengers. Although "final users" feedback was not on the scope of this research, it is considered very relevant for further investigation.
- Biased approach: an "outside" the studio perspective is considered relevant in further investigating Form Language aspects. This would be possible if the researcher is someone not involved in the studio process which could provide an insightful comparison with the current research.
- Form Language Model: further investigation can be developed using the proposed Model and applying to other design studios, in a professional or academic environment. A Form Language Model in the future should account for emergent areas of design, such as Service Design and UIX, in which the constant upgrades and iterations with the clients, partners and final users should be taken into account.

PART VI – REFERENCES

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Tese especialmente elaborada para a obtenção do grau de doutor