The effectiveness of graphic representation techniques used by industrial designers for the conceptual presentation of new products

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Abstract
Graphic techniques are very important means for designers. They can improve the conceptual presentation of new products before a client or a company, stimulating the communication of their potential, defending their benefits and making clear their commercial viability. To choose the most suitable graphic languages is essential so that the client can understand the proposal, allowing this way to establish a dialogue with the designer itself in order to improve the solution. Today the multiplication of graphic media has made it possible for the designers to have a wide range of ways to conduct and present their ideas, but it may happen that the graphic techniques chosen may not always be the most appropriate.
This work aims to demonstrate the importance of graphic expression used as a tool for presenting ideas about new products, and evaluate the effectiveness of several graphic techniques in improving the client's understanding of the product, taking into account the conceptual clarity, the representation of the mode of use, the relationship with the user and the contextualization of the product in its habitat or use environment.

Keywords
Graphic media, industrial design, concept, product design, habitat

1. Introduction

The emergence and democratization of new screen-equipped devices, the reduction of its size and the increase of the bandwidth in the data transmission have led to the emergence of a global scenario in which communication uses highly visual languages and makes use of increasingly universal graphic resources. Through multiple ways, it is possible to access all kinds of information at all times and everywhere, and as a consequence, activities such as leisure, work and interpersonal communication have seen the boundaries of their traditional space diluted to face new ways to develop and new places to be practiced.

The emergence of this environment marked by the omnipresence of the various screen formats reminds us of the potential and importance of the image in any communication process. Its ability to encode a lot of information and to use referents easily identified by various cultures makes it easily understandable by many communities, overcoming in many cases the barrier that usually imposes verbal language to convey concepts or ideas.

Many authors have emphasized the importance of the image to communicate ideas, in several fields. Graphics have been indispensable tools for social and cultural evolution, and drawing is defended as a key agent in the interaction of knowledge and communication. While some have emphasized the general importance of schemas and diagrams as effective tools for understanding complex concepts, ideas, and relationships (Crilly et al., 2006), others go further and argue that graphical representation is not just a means for rapid information uptake, but a vehicle and instrument in the process of acquiring knowledge, so that the development and implementation of graphic language requires a certain maturity (González et al., 2004). In this regard, we consider that although the inclusion of aesthetically attractive elements in a display can favor a better understanding and acceptance of the content, can sometimes reduce the effectiveness of the message if not applied with the correct criterion, and may distract the observer with unnecessary details (Brath et al., 2005).

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Study drawings, as a medium for graphic thinking, can play a prominent role in any design work process (Herbert, 1988). Drawings, illustrations and visualizations have a long tradition also in the field of landscape architecture. The designer communicates his or her ideas and concepts through these media to other people involved in the planning process (Bishop et al., 2005), favoring the workflow.

In the area of product design, it is essential to correctly convey a concept to the client, but also to use the right graphic resources to communicate the ideas to the rest of the work team. Nowadays, collaborative work through new technologies has acquired great importance in this discipline (Chulvi et al., 2017), making it especially necessary to work with adequate images capable of transmitting ideas in a correct way and thus speed up the teamwork process. The new technologies have favored collaborative work, especially in non-presential design teams (García-García et al., 2015, Mulet et al., 2013), demonstrating that knowing how to generate easily understood images that do not require a verbal explanation for its understanding is an even more justified need, and a challenge that arises in the current Information Society.

Nowadays there are many graphic tools for communicating ideas in the field of design (Garcia-García et al., 2016), but it is worth asking if they are really effective, or if we always choose the most appropriate graphic language. For years, digital tools have coexisted with traditional ones, but making a correct use of them in every part of the work process remains indispensable when it comes to effectively communicating an idea. Sometimes we find that when presenting a project to a client or company he or she does not understand the graphic language used by the designer, or that language is not the most appropriate for the proposal that is being presented, and because of this many projects do not prosper.

In this context, it is essential for the designers to communicate their ideas effectively through appropriate graphical representations. Therefore, it is necessary to study how current designers work graphically the concept of a new product, to see which are the most

used representation techniques and to reflect on their effectiveness in presenting this concept to a client.

2. Main objectives

This work aims to demonstrate the importance of graphic expression used as a tool for presenting ideas about new products, and evaluate its effectiveness in the process of communication between the designer and a client or company. For this purpose, we propose to investigate two aspects:

a) To determine which graphic representation techniques are the most used in the field of design to conceptually represent a new product.

b) Evaluate the utility or real effectiveness of these graphic techniques in improving the client's understanding of the product, taking into account the conceptual clarity, the representation of the mode of use, the relationship with the user and the contextualization in its habitat.

3. Methodology

3.1 Overview

Two different activities are proposed in the research process. The first is developed with teams of novice designers during several work sessions, and the second is developed in collaboration with professional design studies. The ultimate purpose is to obtain data about the importance of graphic representations during the designer's work process and during the process of communicating an idea. Several cases are analyzed, assessing to what extent the graphic representation of the product in its context of use helps to understand it better.

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3.2 Proposal and working teams

The first part of the research compares and evaluates the effectiveness of the graphic media used by several groups of novice designers to present a new product for the habitat that responds to the brief of a fictitious company, and to design the living space where it will be used. It is assessed in each case if the representation technique used by the designers has been effective during the process of communication of the idea to the company and if the graphic representations of the living space where the product will be located have helped to better understand the product, its context of use and its relationship with the user.

For this, 10 work teams are formed between 4 and 5 people (T1 to T10) and each will develop the design of a new product. To guarantee homogeneity of the sample, participants who have received similar university training in industrial design, aged between 21 and 37 years old, have been chosen (Figure 1).

TEAM	Men	Women	Total members	Average age (years)	Product developed
T1	1	3	4	21,2	Recyclable cardboard paper bin
T2	2	3	5	21,8	Tupper for food
T3	4	0	4	26,0	High-end chair for home use
T4	4	1	5	28,4	Public park bench
T5	1	4	5	23,8	Kitchen Wall Spice
T6	0	5	5	22,2	Outdoor bench for private gardens
T7	0	4	4	21,5	Indoor multipurpose lamp
T8	1	3	4	23,5	Indoor floor lamp
T9	2	2	4	22.5	Furniture for bottles and cups
T10	2	2	4	21,0	Private garden lounger

Figure 1. Sample characteristics (teams of novice designers).

Throughout the activity, each team will be paired with another randomly chosen team, and both will act with a double role: first as company team, elaborating a brief for the other team, and then as a design team, analyzing the brief of the other team (who will assume the role of company) and proposing a design of a product for the habitat, according to their requirements. The teams are paired as follows: T1 with T2; T3 with T4; T5 with T6; T7 with T8 and T9 with T10.

3.3 Working sessions

Once the teams have been set up, the proposal is organized in 4 working sessions:

Session 1:

- Each team will begin to work as a company, writing a brief as complete as possible with which to request to other team the creation of a new product, framed in current market trends and related with a previously studied philosophy. The brief should follow the sections: description of the situation, background, target audience, estimated budget, objective of the designed product and main benefit.

Session 2:

- At the beginning of the session, each team (company) will deliver the completed brief to another team, which will act as a designer team from now on.

- Each team (as a design team) will carefully analyze the brief provided by the other team (company). Then they must create a written report to evaluate each section of the brief.

- After the analysis, and with the report already written, each team will meet with the other to perform a counter-briefing. First, one team will act as a designer and the other as a company (discussion of the first brief), and then the reverse (discussion

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of the second brief). The objective is to propose changes or improvements in both briefs, in order to better focus the work.

- Each design team will graphically present a product proposal (concept art, sketches, explanatory drawings of how it works, comments on the functions, etc.) as specified in the brief. The new product is defined to the maximum, with all the drawings, diagrams, general plans, infographics or animations that are necessary. Ambiences are created to represent the product in its natural environment of use, in order to improve its understanding by the company team.

Session 3:

- Each designer team will deliver to the company team the graphic material that illustrates their product proposal.

- Each company team will analyze the proposal of the designer team, and will meet with it to discuss it. With the indications of the company, each designer team will continue working on the proposal.

Session 4:

- Each team will deliver to the other all the final visual material (concept art, sketches, explanatory drawings, diagrams, infographics, animations, space environments, etc.).

- Each team, acting as a company, will evaluate the final proposal of the other team according to the following aspects: if the product meets the requirements of the corrected brief (features, uses, benefits, etc.), if the product has taken into account the target audience and is well aimed at them, if the product can meet the established objectives, and if the product complies offering the user the main benefit specified in the brief.

After completing the work proposal, the team partners evaluate each other the final material presented, rating on a numerical scale from 1 to 10 several issues related to the graphic

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representation of the product and its use environment, such as the adequacy of the representation technique, if this representation has contributed to improve the conceptual clarity, or if the graphical representations of the living space where the product will be located have helped to better understand its context of use and its relation with the user (Figure 2).

Regarding the graphical representation of the product	← nothing ... a lot →									
	1	2	3	4	5	6	7	8	9	10
The technique of representation has been adequate										
The graphical representations have helped to better understand the concept of the product										
The graphical representations have helped to better understand the way of using the product										
Regarding the graphical representation of the use environment	← nothing ... a lot →									
	1	2	3	4	5	6	7	8	9	10
The technique of representation has been adequate										
The representations of use environment have helped to better understand use context of the product										
The representations of the use environment have helped to better understand the relationship with the user										

Figure 2. Questionnaire to be completed by each company team (evaluating the work of the designer team)

Finally, each design team is asked to rate on a scale from 1 to 10 the importance of graphic representations in the process of communicating an idea, according to the experience derived from this activity. In the same way, each team marks the representation techniques that has used (Figure 3).

	← nothing				…				a lot →
	1	2	3	4	5	6	7	8	9	10
Defending an idea with graphic support has helped you to explain it better?										
Mark the graphic representation techniques you have used to present your proposal	Manual sketch (pencil, watercolor, marker pen, etc.)									
	Infographic sketch (Paper 53, Adobe Sketch, Adobe Draw, etc.)									
	3D virtual modeling (static image)									
	3D virtual modeling (animation)									
	Photomontage									

Figure 3. Questionnaire to be completed by each designer team.

3.4 Survey aimed at professional design studios

In order to obtain information contrasted with the professional reality, a survey was carried out to ten prestigious design studios based in Spain that had a consolidated professional career centered in the field of product design for the habitat, recognized both nationally and internationally. Studies surveyed were: Aa Studio (albertoarza.com), Cerámica a mano alzada (ceramicaamanoalzada.com), Clausell Studio (clausellstudio.com), Dsignio (dsignio.com), Equipo Nómada (equiponomada.es), Ignota Design (ignotadesign.com), Nes (nesestudio.com), JoanRojeski Studio (joanrojeski.com), Vitale (vitale.es) and Yonoh (yonoh.es).

The survey was conducted electronically. Based on their accumulated professional experience, they were asked about the usefulness of the graphic representation to present an idea or concept of a product to a company or client, if representing a product in a habitat or context of use makes the product better understood, and whether to represent a product in its habitat or context of use helps to better understand its relationship with the user. Valuations were performed on a numerical scale from 1 to 10, with 1 being the lowest value

and 10 being the highest. In addition, the studios were asked to indicate which graphic representation techniques they used to present their proposals to their clients, in order to compare them later with the techniques used by the newly graduated designers.

4. Results

About the teams assuming the role of designers (Figure 4), the results obtained show a very high valuation of the support of the graphic resources in the process of presenting and explaining a new product before a fictitious client, in this case, another of the teams that have collaborated in the activity assuming the role of a company. From the same questionnaire, it can be seen that the most used techniques of representation by novice design teams are manual sketching (drawing in pencil, ink and marker), 3D modeling (image) and photomontage (integration of manual drawings and 3D modeling in real backgrounds digitally intervened).

		NOVICE TEAMS											
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10		
	Defending an idea with graphic support has helped you to explain it better?	10	10	9	10	9	9	9	9	10	10	9.5	Average
Graphical techniques used	Manual sketch	+	+	+	+		+	+	+	+	+	90	Percentage
	Infographic sketch	+	+	+	+			+			+	60	
	3D virtual modeling (image)	+	+	+	+	+	+		+	+		80	
	3D virtual modeling (animation)											0	
	Photomontage		+	+	+	+	+		+	+		70	

Figure 4. Results of the questionnaire completed by the novice teams in their 'designer' role.
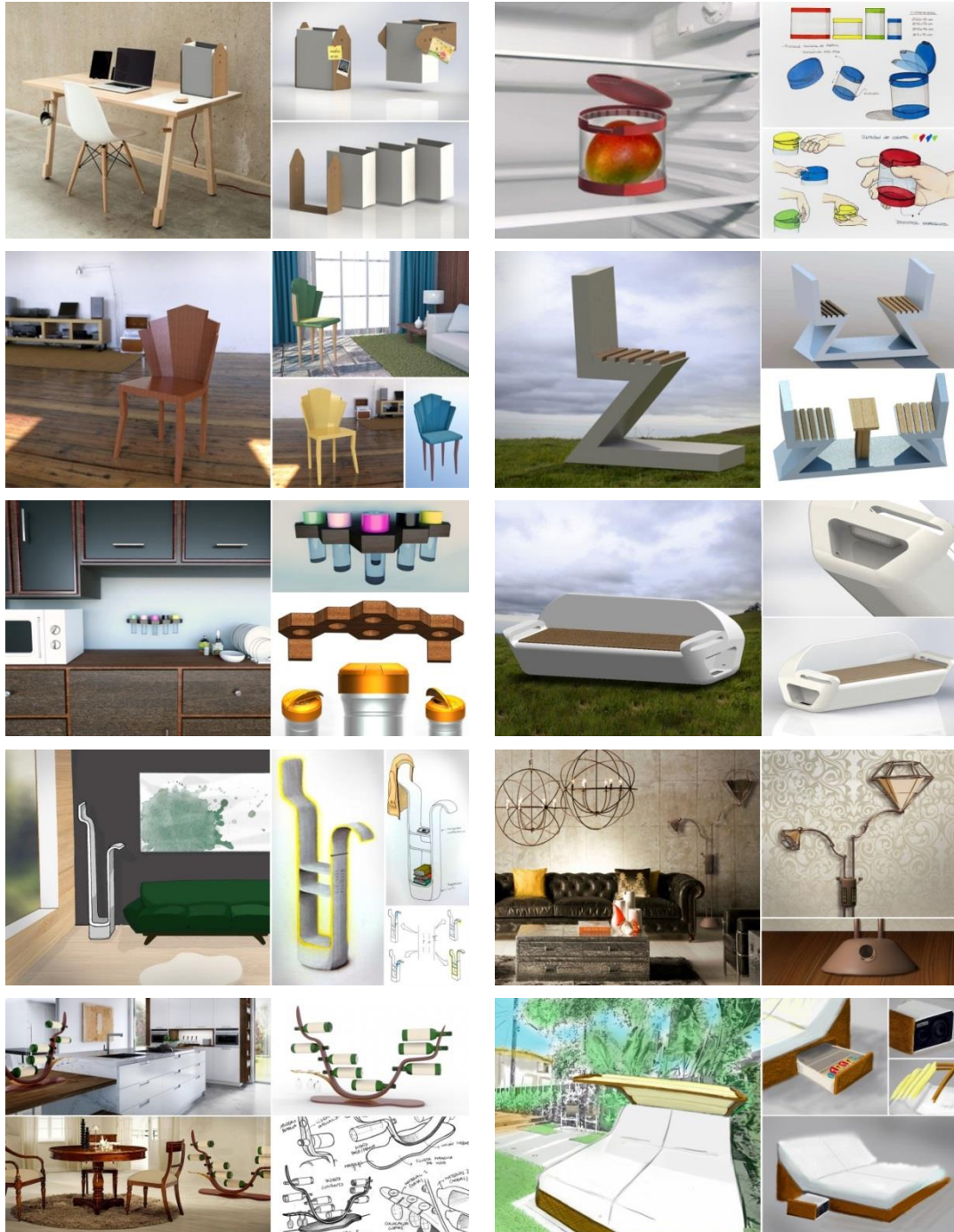
Figure 5. A selection of final graphic proposals of all novice teams (T1-T10): representation of the product and the living space where it will be used. Left to right and top to bottom: T1 and T2; T3 and T4; T5 and T6; T7 and T8; T9 and T10.

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	ITEMS TO BE EVALUATED	RATING										Average ratings	
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10		
Regarding the graphic representation of the product	Adequacy of technique (quality of execution)	9	9	10	10	8	10	6	8	10	8	8.8	9.1
	Understanding the idea (conceptual clarity)	10	8	10	10	9	10	8	9	10	10	9.5	
	Understanding how to use the product	10	7	10	10	8	10	8	8	10	9	9.0	
Regarding the graphical representation of the environment (habitat)	Adequacy of technique (quality of execution)	10	7	10	10	10	8	7	8	10	8	8.8	8.7
	Understanding use context of the product	10	7	10	10	9	8	7	8	10	9	8.8	
	Understanding the relationship with the user	10	8	10	10	8	8	7	5	10	9	8.5	
	Average ratings	9.83	7.66	10	10	8.67	9.0	7.17	7.67	10	8.83		

Figure 6. Evaluation of each proposal by the other team: product and environment (habitat).

The evaluation of the final graphic proposals of each team by the other (Figure 6) has proved to be high in all cases, with an average score higher than 7 points out of 10 in all teams. It is observed that the best rated teams made use of both manual and 3D modeling techniques to represent the product and its environment of use. It should be noted that the team whose proposal obtained the lowest global rating used only manual drawing techniques to represent both the designed product and the natural habitat or context of use. In contrast, proposals that used digital 3D modeling techniques to represent the habitat or product were better rated. While the conceptual clarity was the best rated aspect (9.5 points out of 10), the understanding of the product-user relationship through its representation in the use environment was the worst rated aspect (8.5 points), in many cases because in the

drawings the user was not explicitly represented using the product in its habitual environment.

PROFESSIONAL DESIGN STUDIOS (focused in product design for the habitat)	Utility of the graphical representation			Graphic techniques used					
	Utility of the graphic representation to present an idea or concept to a company / client	Representing a product in a habitat or context of use makes it better understood	Representing a product in a habitat or context of use helps to better understand its relationship with the user	Manual sketch	Infographic sketch	3D virtual modeling (static image)	3D virtual modeling (animation)	Photomontage	Other
Aa Studio	10	10	10		+	+		+	+
Cerámica a mano alzada	10	10	10	+	+			+	
Clausell Studio	10	7	7	+	+	+		+	
Dsignio	10	7	7			+			
Equipo Nómada	10	10	10	+	+	+		+	
Ignota Design	10	10	10	+	+	+		+	
Nes	9	10	10	+	+	+	+	+	
JoanRojeski	10	7	9			+		+	+
Vitale	10	10	10			+		+	+
Yonoh	10	8	8	+		+	+		
	9.9	8.9	9.1	60	60	90	20	80	30
	Average ratings			**Percentage**					

Figure 7. Results of the survey to 10 professional studios specialized in habitat design

The survey of ten professional design studios (Figure 7) reveals that, according to the accumulated experience of their members, the use of graphic representation support in presenting an idea or concept about a product to a company or client is indisputably very

useful. In the same way, all studios coincide in pointing out that, in the exercise of their profession, the proper representation of a product in its habitat or context of use contributes to a better understanding of the product and helps to understand its relationship with the user.

This survey also shows that the most commonly used techniques in the field of product design related to habitat are usually 3D virtual modeling and the photomontage. The techniques of manual and infographic sketching, widely practiced by novice teams, are here moderately significant.

5. Conclusions and discussion

In light of the present work, and after analyzing the opinion of novice design teams and consolidated studios, it seems that the use of graphic resources is very useful for the designer when presenting and defending a project before a client or company. The immediacy of the image to convey complex ideas and its ease to be understood, often without the need for words, make it a valuable support instrument in any communication process.

This study has allowed us to determine that manual sketching, photomontage and 3D virtual modeling are the most commonly used graphic expression techniques in the design field to conceptually present a new product. One possible explanation for the preference of working with these techniques rather than with others (3D animation, for example) may be that they offer the design team a greater immediacy when representing a product concept in early stages, and that such immediacy offers a clearer and direct vision of the main attributes to be highlighted. However, this requires further research to be discussed.

In any case, using a more elaborate graphic technique or a simpler one does not always necessarily guarantee that the client to whom the proposal is presented will understand it correctly. Other factors such as the complexity of the content to be represented, the details displayed, the quality of the execution or the sequence in which the images are shown are

possibly involved. It is convenient to consider the simultaneous use of several graphic techniques in the presentation of a design project, since some aspects, such as conceptual ones, maybe can be better understood through more immediate techniques (manual sketches) and others, such as accurate volumetrics or surface qualities, are better understood through more advanced techniques (3D virtual modeling).
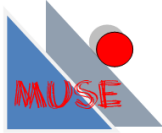
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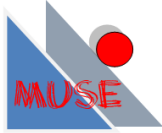
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