

Multidisciplinary Journal for Education,
Social and Technological Sciences

<https://doi.org/10.4995/muse.2017.6349>
ISSN: 2341-2593

Sketching as a communication tool and a vehicle for exploring new ideas in Higher Education of industrial design. Implementation and analysis of new methodologies

José Luis Navarro

Francisco Felip Miralles

*Universitat Jaume I, Departamento de Ingeniería de Sistemas Industriales y
Diseño, email: jnavarro@uji.es*

*Universitat Jaume I, Av. de Vicent Sos Baynat, s/n. 12071 Castellón de la
Plana, email: ffelip@uji.es*

Received: 2017-03-30; Accepted: 2017-08-11

Abstract

Freehand drawing is a basic tool to explore shapes and visualize ideas during the first phase of projective process in industrial design. Sketches, expressive and quickly executed, allow designers to highlight the most interesting aspects of the product to be designed and help to define its shape and general features. Due to the immediacy that characterizes the manual drafting industrial designers in training learn to become able to translate any ideas graphically and thus able to communicate with other designers, initiating a dialogue on the product to be designed. In the Bachelor's Degree in Industrial Design and Product Development Engineering at the Jaume I University of Castellón (Spain), the subject 'Artistic Expression II' maintains and strengthens the knowledge gained in other subjects about the different graphic techniques, making drawing a means of expression for represent, synthesize and define the shape of objects. However, it has been found that the subject procedures were not adequate to achieve the learning results proposed, so it was necessary to apply a new approach. This paper describes the implementation of a new methodological strategy on this subject, adapting it to the European Higher Education Area, with the aim that students in

Industrial Design acquire the four core competences of this matter. We describe the activities designed to achieve each of the competences and the implemented methodology for each of these activities. Finally, the results are analyzed and the overall positive impact of the measures taken is discussed.

Keywords

Product design, drawing, sketching, creative process

1. Introduction

1.1 The role of drawing in design

Drawing as a projective tool for shaping new ideas is indispensable in the academic training of industrial designer. Hand drawing favors the development of creativity in the field of design, while allowing communicating the first ideas about new concepts. To practice the basic components of hand drawing, as the line, composition, color, perspective and chiaroscuro, is necessary for teaching disciplines such as architecture and the design of spaces (Travis 2014), but can also be relevant for industrial design, since they share many of their creative approaches. Some studies have also defended the hand drawing and model making as activities closely related to the design process, to help familiarize the user with the geometry of objects, that is, to understand the space around us and forms contained therein (Carnevale 2015).

Lasseau (2001) highlights the need to develop graphical manual skills to practice graphic thinking and enhance this way the acquisition of perceptual skills, emphasizing its importance for architects and designers as a mechanism of representation, conceptualization and abstraction for communication between the creator and his audience. Design drawings, as a means to graphic thinking, therefore have a prominent role in any process of design work (Herbert 1988).

Drawing requires learning certain skills, but is merely a rational part of the design process, which is more complex and requires a creative mind. It is possible to draw

without designing, but not vice versa. That is why teaching drawing in the field of industrial design is so necessary.

1.2 'Artistic expression II' subject: description and detection of shortcomings

This subject is taught from September to December in the second year of the Bachelor's Degree in Industrial Design and Product Development Engineering, maintaining and strengthening the knowledge acquired in the different graphic techniques introduced in 'Artistic expression I', by making drawing a means of expression to represent, synthesize and define the shape of objects. The skills to be acquired by students in this subject are important because they will use them throughout the Degree in many other subjects focused on conceptualizing new products, such as 'Model making workshop', 'Conceptual design', 'Product presentation' or 'Product design prototyping workshop', where it is necessary to know how to represent graphically the ideas and present them in public, in order to receive feedback and improve them before building physical models or prototypes.

In this subject students work on issues such as the composition and shape analysis (shape psychology and compositional principles), light, volume and formal expressiveness (point, line, stroke, spot color, chiaroscuro and techniques of artistic expression and presentation), color (theory, perception, semantics and symbolism of the colors and texture of the industrial product), descriptive illustration (the human figure and its relation to objects, proportion, stylization and synthesis) and architectural space (intuitive representation of perspective). The methodology used has always been eminently practical, but the approach conducted so far has not been entirely satisfactory, since it has been found that students fail to acquire the necessary skills and do not apply them correctly in later courses.

Among the shortcomings that have been detected in students from other years after completing this subject, we found a lack of confidence to represent new ideas. They find it very difficult to draw what they can't see, and they don't know how to represent it.

Normally students often prefer verbal explanations to drawing when presenting their new products and ideas. In addition, when drawing these new products they always use two-dimensional representations (front or side views), although in reality these products would have three dimensions and they will be understood more quickly if they were represented in perspective.

The explanation of these shortcomings is found in the methodology carried out so far on the subject, too focused on copying and tracing photographs of real objects to interpret them graphically later, instead of drawing physical objects after manipulating them or watching them directly. To learn how to graphically represent and interpret the geometry of the objects around us is necessary to observe our environment carefully and become familiar with spatial depth that defines it, which has direct influence on our perception and understanding of space. Thus, once the industrial designer learns how to represent on paper a volume that sees in real space, it may be easier for him or her to represent other volumes not seen. Additionally, to improve manual sketching skills it is also required daily, continuous and intensive practice during the entire course, using hand-drawing in each design project developed by students (Dong et al. 2013).

2. Methodology

2.1 Analyzing the students

In order to learn more about the students of this subject an anonymous and voluntary survey was conducted early in the course. The intention was to find a number of factors that could influence the development of learning during the course, and thus better align the contents and schedule of activities of the subject. This survey asked the students:

- 1) What was their previous training in high school: technical, artistic or humanities.
- 2) The perception of the importance of the subject 'Artistic Expression II' for their training in the Grade (evaluating it on a 10 point grading scale).

- 3) What was their skill level in subjects related to artistic or graphic expression before starting the Bachelor's Degree (evaluating it on a 10 point grading scale).
- 4) What was their skill level in subjects related to artistic expression before starting the subject 'Artistic Expression II' (evaluating it on a 10 point grading scale).
- 5) Rate from 0 to 10 points the interest or love for drawing and the use of techniques of artistic expression in their daily lives.
- 6) To point out with which of this five branches related to design feels more affinity, from highest to lowest technical nature: A) engineering and industrial technology, B) engineering and product design, C) product design and graphic design, D) design and visual arts, and E) Fine Arts.

The survey was answered by 80 students (80% of students enrolled). The first question allowed us to see that 70 students came from technical high school, 6 came from art school and 4 came from humanities high school. This data corroborated the affinity of the previous formation of most students with the technical character of the Degree in Industrial Design that they are studying.

Regarding the second question, the average perception of the importance of the subject proved to be 8.56 points out of 10, detecting 4 points as the lowest value (one student) and 10 points as highest value (31 students).

In the third and fourth questions the students reported having an average skill of 4.73 points out of 10 in artistic expression matters before the Bachelor's Degree, and 6.04 points right at the beginning of this subject, which indicates that the perception of their skills improved during the first year of the Degree.

The fifth question allowed us to find out that their average interest in drawing outside academic environment was 7.73 points out of 10, indicating a willingness of students towards the use of tools of artistic expression in their daily lives.

The answers to the last question indicated a dominant trend towards engineering and product design, followed by product design and graphic design, engineering and industrial technology, design and the visual arts and finally Fine Arts (see Figure 1).

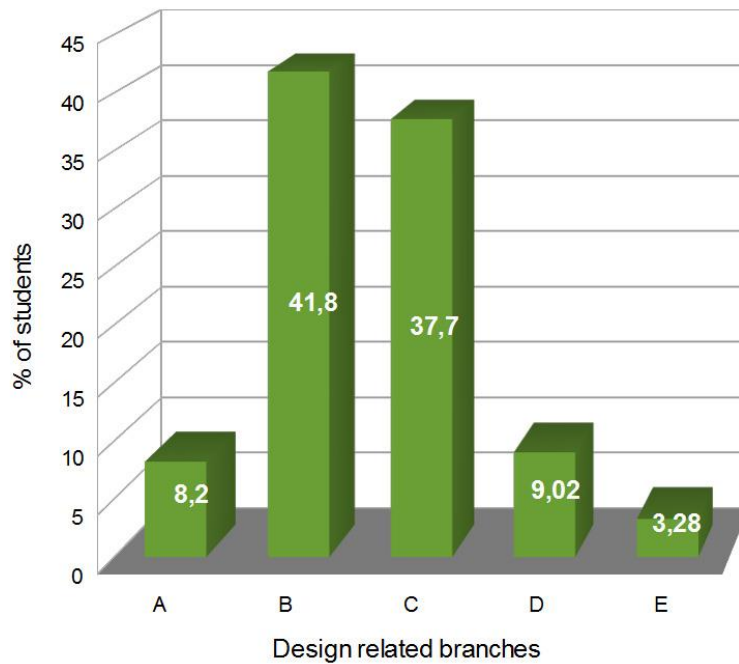


Figure 1. Affinity of students in 'Artistic Expression II' to 5 design related branches: A) engineering and industrial technology, B) engineering and product design, C) product design and graphic design, D) design and visual arts, and E) Fine Arts.

Overall, the initial survey allowed to prove that although most students had a solid technical formation prior to University and a natural tendency to the most technical fields of design, they considered very important artistic training for the exercise of the designer profession. Although they claimed to have poor skills in artistic expression, a predisposition to keep improving is observed; therefore it is possible to achieve an improvement in their skills after the course by adapting exercises to their initial abilities.

2.2 Preparing exercises to achieve the skills of the subject

The skills to achieve through this subject, previously defined in the curriculum of Bachelor's Degree, were as follows:

- CE23 - Creativity and innovation in the field of design
- CE24 - Being able to communicate effectively orally and in writing, written reports and all the written and graphic documentation necessary to communicate ideas and projects.
- CE5 - To handle techniques and tools for artistic expression and representation.
- CG5 - Motivation for quality

To ensure that students could finish the subject acquiring the abilities necessary to develop the planned skills, a series of exercises were designed (see Table 1) and were distributed in 12 categories:

- Category 1: Analysis and interpretation of geometric volumes (part 1). Through 7 conceptual experimentation exercises (1A-1G) students attempt to reactivate the knowledge acquired in the previous course. Such practices also serve to disinhibit the capacity to respond to new artistic expression problems that arise.
- Category 2: Analysis and interpretation of geometric volumes (part 2). Through various exercises students practice tactile perception of volume or shape that is imaged with their hands (exercises 2A and 2B) practicing both geometric and organic shapes. Another exercise (2C) uses an object of cylindrical shapes, and the student has to imagine and draw a nonexistent membrane to give a sense of continuity between different volumes, as if it were a slightly stretched skin over a structure. Through these topological surfaces students discover that things are not just as they look, but they can be the internal structure of an organic form. Exercises 2D and 2E are interrelated, and are to capture the essential shape and structure of a moving object, to achieve a mental synthesis of the structure and basic volume of the object (scale and proportion), but eliminating curves and

converting the object into a complex polyhedron. In the next phase (exercise 2E) students had to draw the same figure but with the material texture of the real object: the glass as glass, liquid as liquid and metal as metal, since it was a simple transparent bottle of perfume.

- Category 3: analysis of everyday objects: seesaw toy. Through 3 exercises (3A-3C) students had to try to understand the product observed from different points of view by representing and interpreting it with different graphic techniques.
- Category 4: analysis of everyday objects: taps. Through 4 exercises (4A-4D) students had to become familiar with the formal identity of a very common household industrial product, learning its mode of operation from handling, direct observation of its volume and the representation of its parts.
- Category 5: analysis of everyday objects: electrical appliances (part 1). Through 3 exercises (5A-5C) students had to familiarize themselves with the formal identity of various small electrical appliances, representing them from various points of view and using various graphic techniques.
- Category 6: analysis of everyday objects: electrical appliances (part 2). Deepening understanding of domestic appliances by means of 3 exercises (6A-6C), practicing exploded views to become familiar with the formal and functional meaning of the components of an industrial product, while chromatic interpretation is used as a resource to represent the volume of a product without using perspective.
- Category 7: analysis of everyday objects: electrical appliances (part 3). By means of 4 exercises of handling and direct observation (7A-7D) is intended for students to understand that the volume of products is directly related to its ergonomic features, and learn to propose functional improvements and represent them by sketching.

- Category 8: analysis of everyday objects: vehicle. 3 exercises (8A-8C) to practice the observation of large industrial products and its representation with different techniques from different points of view.
- Category 9: street / domestic furniture and architecture. Through 3 exercises (9A-9C) is intended for students to associate the products for habitat with their spatial context, representing both as a single whole. The concept of 'graphic animation' is introduced: to enhance the visual expressiveness of the drawings by textures or tracings of the students' own unique style, avoiding representing the surfaces with excessive blurring or smoothing.
- Category 10: design a mascot for an event or for a company. Through this exercise (10A) is intended that students learn to work together in an agile way sharing their ideas through sketches and working collaboratively.
- Category 11: resources for show ideas: presentations and digital compositions. Exercise 11A familiarizes students with the use of digital photo retouching tools, learning to integrate several photos into a single one changing various parameters such as color, brightness, contrast and saturation. Exercise 11B serves the students to practice their oral communication skills to objectively defend in public their own personal portfolio.
- Category 12: design project: design of a piece of furniture or lighting. Through exercise 12A students practice the graphic composition of various elements in a bidimensional space, learning how to distribute them with the intention of creating a visual narrative discourse.

Table 1. Distribution of exercises to be performed, the competences to achieve and the methodology implemented for this purpose in each case.

Competences	Activities or exercises to achieve the	Implemented methodology
-------------	--	-------------------------

CE23	CE24	CE5	CG5	competences	
		X		1A. Interpretation of a mental image from a descriptive narration with geometric volumes.	Linear perspective drawing with 2B pencil on paper. DIN A4.
		X		1B. Interpretation of exercise 1A changing the organization of the construction elements and keeping the plane of symmetry.	Linear perspective drawing with 2B pencil on paper. DIN A4.
		X		1C. Formal reproduction through tactile experiences (several elements).	Linear perspective drawing with 2B pencil on paper. DIN A4.
		X		1D. Interpreting cylindrical volumes of the proposed model using prismatic shapes	Linear perspective drawing with 2B pencil on paper. DIN A4.
		X		1E. Conceptual interpretation of exercise 1D from a different point of view, without observing the analyzed model.	Linear perspective drawing with ballpen on paper. DIN A4.
		X	X	1F. Chiaroscuro drawing of a model, perspective view.	2B pencil on paper. DIN A4.
		X	X	1G. Pointillist chiaroscuro interpretation from exercise 1F.	Ballpen or fine tip marker on paper. Blue or black color. DIN A4.
		X		2A. Shape recognition by tactile experiences.	Linear perspective drawing with 2B pencil on paper. DIN A4.
		X		2B. Formal reproduction through tactile experiences (several elements).	Linear perspective drawing with 2B pencil or ballpen, on paper. DIN A4.
		X		2C. Interpret by membranes or topological surfaces the cylindrical volumes of the model analyzed in the exercise 1F.	Chiaroscuro drawing in perspective. Free technique. DIN A4.
		X		2D. Geometric synthesis drawing in perspective view of a moving object.	Ballpen on paper. DIN A4.
		X	X	2E. Free color interpretation of the 2D exercise, emphasizing the materiality of the object.	Crayons or markers on paper. DIN A4.
		X		3A. Linear perspective drawing of the proposed model.	2B pencil on paper (2 different points of view). DIN A4.
		X	X	3B. Interpretation of a new point of view of the model by chiaroscuro of linear tracings	Fine tip marker pen, pen nib and ink, stylographs or other permanent means of black, brown or blue color, on paper. DIN A4.
		X	X	3C. Interpretation by spot colors of one of the points of view studied in exercise 3A or 3B.	Marker pens, colored inks or tempera paint on paper. DIN A4.
		X	X	4A. Sketching a tap considering its volume and not its materiality.	Linear perspective drawing with 2B pencil on paper (2 different points of view). DIN A4.
		X	X	4B. Monochromatic interpretation by line and spot of a new point of view of the tap or another	Marker pen, ink or watercolor pencil on paper. DIN A4.

				different model.	
	X	X	X	4C. Linear perspective drawing showing the operation of a tap by representing the hand in attitude of use. Indication of elements and / or parts of the object by reference lines or arrows with explanatory text.	HB pencil on paper, reinforcing lines using black marker (fine and medium thickness). DIN A4.
		X	X	4D. Linear perspective drawings of 2 different taps belonging to the same formal family (sink, toilet, bidet, kitchen).	Ballpen on paper. DIN A4.
		X	X	5A. Linear perspective drawing of one of the proposed models (hair dryer, drill, electric saw).	Blue ballpen on paper (2 points of view). DIN A4.
		X	X	5B. Chiaroscuro drawing in both color and perspective, showing the selected object in the exercise 5A from another point of view.	Crayons on paper. DIN A4.
		X	X	5C. Linear perspective drawing of a typical small household electrical appliance (blender, coffee maker, juicer, etc.).	Free technique on paper. DIN A4.
	X	X	X	6A. Linear perspective drawing of exploded view of one of the proposed models (hair dryer, drill, electric saw).	2B pencil on paper. DIN A4.
		X	X	6B. Sketch of one of the models proposed in the exercise 6A, showing by a single orthogonal projection (elevation view or profile view) as a basic representation of a product.	HB pencil on paper. DIN A4.
		X	X	6C. Chromatic interpretation of sketch 6B in order to generate volumetric sensation	Free technique on paper. DIN A4.
	X	X	X	7A. Ergonomic study. Linear perspective drawing of one of the proposed models (hair dryer, drill, electric saw) representing the hand in gripping or clamping position (two points of view).	2B pencil on paper. DIN A4. In one of the drawings the student must reinforce the object's contour line using a black marker pen, while the hand drawing will remain in pencil.
X		X	X	7B. Redesign of one of the models proposed in practice 7A through chromatic chiaroscuro drawing in perspective.	Free technique on paper. DIN A4.
		X	X	7C. Line drawing of a domestic power tool, strengthening contour and main areas using thicker lines.	Fine, medium and/or thick tip marker pen. DIN A4 or DIN A3.
		X	X	7D. Color or monochrome interpretation of exercise 7C, in order to represent three-dimensional appearance by spot colors.	Marker pens, inks, watercolors or watercolor pencils on paper. DIN A4 or DIN A3.
		X	X	8A. Line perspective drawing of a vehicle (car or motorcycle)	Blue ballpen on paper. DIN A4.
		X	X	8B. Chiaroscuro perspective drawing of the object (another point of view, different from exercise 8A).	2B pencil on paper. DIN A4.

X		X	X	8C. Drawing of complete redesign of a vehicle which may be based on exercise 8A or 8B, in chromatic chiaroscuro.	Free expression technique. DIN A4 or DIN A3.
		X	X	9A. Perspective drawing of a furniture element	Ballpen and/or fine or medium tip marker (one point of view). DIN A4.
		X	X	9B. Linear representation of the same furniture element (another point of view, different from exercise 9A), considering the architectural environment in which it is located.	Pencil on paper. DIN A4 or DIN A3.
		X	X	9C. Free interpretation of exercise 9B by graphic animation (color or monochrome).	Free technique. DIN A3.
X	X	X	X	10. Design a mascot for an event or for a company (teamwork, three to four people). Set of linear and expressive drawings representing the shape and nature of the character	Teamwork of three to four people. Pencils, ballpens or fine tip markers. DIN A3.
	X	X	X	11A. Integration of images in different pictures.	Digital image retouching. Recommended software: Adobe Photoshop, Gimp or similar.
X	X		X	11B. Individual presentation of personal portfolio (in 3 minutes).	The presentation should show only a selection of the exercises done in the subject (the most successful). Microsoft Power Point or Open Office Impress.
X	X	X	X	12. Furniture design project according to five different product alternatives.	Representation of the design through a visual panel that includes several previous concept sketches, the orthogonal projections with basic dimensions, elemental product specifications and a color rendering of the final design. DIN A3.

2.3 Use of rubrics

One of the weaknesses identified in previous years referred to the subjectivity with which the students addressed the exercises and their inability to see their own mistakes. In order to direct the student to the acquisition of objective criteria for assessing their own work impartially, some self-assessment rubrics were created to be applied to each group of exercises. Each rubric specifies the various aspects to be evaluated and the criteria to evaluate each of them. The purpose of these rubrics was to provide students with the objective criteria of an industrial designer, with which detect effectively the own



shortcomings and learn to solve them. All exercises, in turn, were evaluated by teachers following the same criteria: fitting, proportion, presentation, formal expression and technique.

DI1018 - 2015 - LA _____ SURNAMES, Name _____

SELF-ASSESSMENT Exercise group #1 (Mark with an "X" the most appropriate score)												
Criteria ▼		VERY POOR (0, 1 or 2 points)			POOR (3, 4 or 5 points)			AVERAGE (6 or 7 points)		CORRECT (8, 9 or 10 points)		
FITTING - PROPORTION - PRESENTATION	Fitting (adaptation to the format and visual expression)	Pretty bad in all cases. Some parts of the drawing does not fit on paper			Bad in some cases. Some parts of the drawing does not fit on paper			The drawing follows the format, but has some frame errors in some cases.		The fit is fine in all cases		
		0	1	2	3	4	5	6	7	8	9	10
	Plotting auxiliary lines and final lines	The line drawing is quite irregular, erratic and with many hesitations in all cases			The line drawing is irregular and with many hesitations in some cases			The line drawing is correct, but with some irregularities or hesitations in some cases		The line drawing is clean and very regular in all cases		
		0	1	2	3	4	5	6	7	8	9	10
Proportions	The constituent elements of the drawing are completely out of proportion in all cases			The constituent elements of the drawing are somewhat out of proportion in many cases			The constituent elements of the drawing are out of proportion in some cases		The constituent elements of the drawing are not out of proportion			
	0	1	2	3	4	5	6	7	8	9	10	
Presentation	At first glance erasures and stains can be seen in almost every exercise			At first glance erasures and stains can be seen in some exercises			Erasures and stains can barely be seen in some exercises		Erasures and stains can't be seen in any exercise			
	0	1	2	3	4	5	6	7	8	9	10	
FORMAL EXPRESSION - CHIAROSCURO - TECHNIQUE	Perspective	The perspective used is poorly developed and is inconsistent in all cases			The perspective used has expression errors and is inconsistent in some cases			The perspective used hardly has expression errors and is consistent in almost all cases		The perspective used has no expression errors and is consistent in all cases		
		0	1	2	3	4	5	6	7	8	9	10
	Expression and interpretation	The interpretation of chiaroscuro by pointillist technique is unconvincing			The interpretation of chiaroscuro by pointillist technique is not very convincing			The interpretation of chiaroscuro by pointillist technique is somewhat convincing		The interpretation of chiaroscuro by pointillist technique is very convincing		
		0	1	2	3	4	5	6	7	8	9	10
	Treatment of chiaroscuro	Chiaroscuro treatment is ineffective in all cases			Chiaroscuro treatment is ineffective in many cases			Chiaroscuro treatment is ineffective only in some cases		Chiaroscuro treatment is effective in all cases		
		0	1	2	3	4	5	6	7	8	9	10
Adequacy to the proposal	The representation has not been adjusted to the requested proposal, both in the topic and in the way it is expressed			The representation has been slightly adjusted to the requested proposal, both in the topic and in the way it is expressed			The representation has been sufficiently adjusted to the requested proposal in the topic, although there have been errors in the way of expressing		The representation has been well adjusted to the requested proposal in the topic, and the way of expressing was appropriate			
	0	1	2	3	4	5	6	7	8	9	10	
Expression technique and support	The applied technique has not been well used in virtually any case			The applied technique has not been well used in some cases			The applied technique has been well used in most cases		The applied technique has been well used in all cases			
	0	1	2	3	4	5	6	7	8	9	10	
SELF-CRITICISM	Self-criticism, participation and motivation for improvement	I think my work is always good and therefore I never try to improve my exercises			I think my work is usually good and therefore I never try to improve my exercises, except in some occasion			I am aware that some exercises are not correct and I try to improve my work sometimes		I am aware that some exercises are not correct and I try to improve my work in almost all occasions		
		0	1	2	3	4	5	6	7	8	9	10
SUM OF ALL THE CRITERIA:											<input type="text"/>	

Figure 2. Example of rubric used in the subject to assess the first group of exercises

3. Results

3.1 Observable results following the implementation of the exercises

The implemented methodology has helped nearly all students to acquire the expected skills. The results of each group of exercises are described below:

- The exercises in category 1 (analysis and interpretation of geometric volumes - 1) got an average mark of 5.3 out of 10 points. It is observed that after a long period of drawing inactivity since they finished the subject 'Artistic Expression I' (4 months), analytical skills and agility to draw are depleted. The results, although most of them are not remarkable, do maintain a similar level, so that 28% of students do not reach the minimum mark of 5 points, but the lowest mark reach 4 points.
- In category 2 (analysis and interpretation of geometric volumes - 2) the same average mark of category 1 is obtained. 27% of students do not reach the minimum mark of 5 points, but the lowest mark reach 4 points. It is noted that students have trouble understanding the conceptual experimentation and expression proposals. Students do not fully understand the need to interpret the visible forms instead of copying them as if they made a picture, or copy them directly from the photos. It is observed that most of them have fear of making mistakes, so they draw very slowly and carefully.
- In category 3 (analysis of everyday objects: toy seesaw) an average mark of 6.0 points is obtained. 91% of students exceed 5 points, an improvement which is a slight recovery of the skills acquired in the previous semester with the subject 'Artistic Expression I'. We can observe greater confidence in the development of exercises compared to initiation exercises 1 and 2.
- In category 4 (analysis of everyday objects: taps) an average mark of 6.1 points is obtained. 98% of students exceed 5 points, indicating the acquisition of a greater

ease when using the proposed techniques. There are still some issues that they need to learn in order to express themselves more freely, because they are accustomed to draw only what they see.

- Exercises in category 5 (analysis of everyday objects: electrical appliances - 1) an average mark of 6.6 points is obtained. 98% of students exceed 5 points, although the average quality of the work is only acceptable. Students have difficulties to simplify and reduce the amount of visual information of the objects observed.
- For category 6 (analysis of everyday objects: electrical appliances - 2) an average mark of 6.7 points is obtained. 98% of students exceed 5 points. It is noted a great improvement in the agility to draw and conceptualize the visible forms, showing more adequate strokes.
- The exercises in category 7 (analysis of everyday objects: electrical appliances - 3) got an average mark of 6.8 points. 100% of students exceed 5 points. Although the proposals in categories 5, 6 and 7 are varied and with different approaches, students seem tired of working with similar models and prefer to draw other objects.
- In exercises in category 8 (analysis of everyday objects: vehicle) an average mark of 6.7 is obtained. 99% of students exceed 5 points. It is noted that students are not accustomed to draw large objects and at first they are not able to interpret the proportions from the point of view of the observer, drawing more conceptually and with great disproportions.
- For category 9 (street / domestic furnishings and architecture) an average mark of 6.5 is obtained. 96% of students exceed 5 points. It is observed that changing the format is more uncomfortable and results are more irregular and of lower quality, in general. Most students are not prepared to represent the interior space intuitively, being more used to drawing objects. However, the incursion on an

issue of this nature has allowed them to exercise in the synthesis of the elements represented, with a consequent improvement in their way of expressing space.

- In the category 10 (design a mascot for an event or for a company) an average mark of 7.6 points is obtained. 100% of students exceed 5 points. The assessment of the work is done jointly (students evaluate each other) and we observe that they are quite critical in their assessments.
- The exercises in category 11 (resources for show ideas: presentations and digital compositions) allowed to note that very few students handle well the image processing programs. Except for a few students, most of them are motivated and strives to achieve a good result. It is also noted that most of the students feel uncomfortable in public oral presentation of their portfolio, probably because it is their first oral presentation in the Bachelor's Degree.
- Finally, the last category (design project: design of a piece of furniture or lighting) got an average mark of 6.5 points out of 10, 98% exceeding 5 points. It is detected that most students have completed the exercise without consulting enough teachers to meet formal, technical and representation issues, probably due to excessive confidence in the abilities acquired and accumulation deliverables of other subjects, which it makes the students accelerate the completion of this exercise and neglect important aspects.

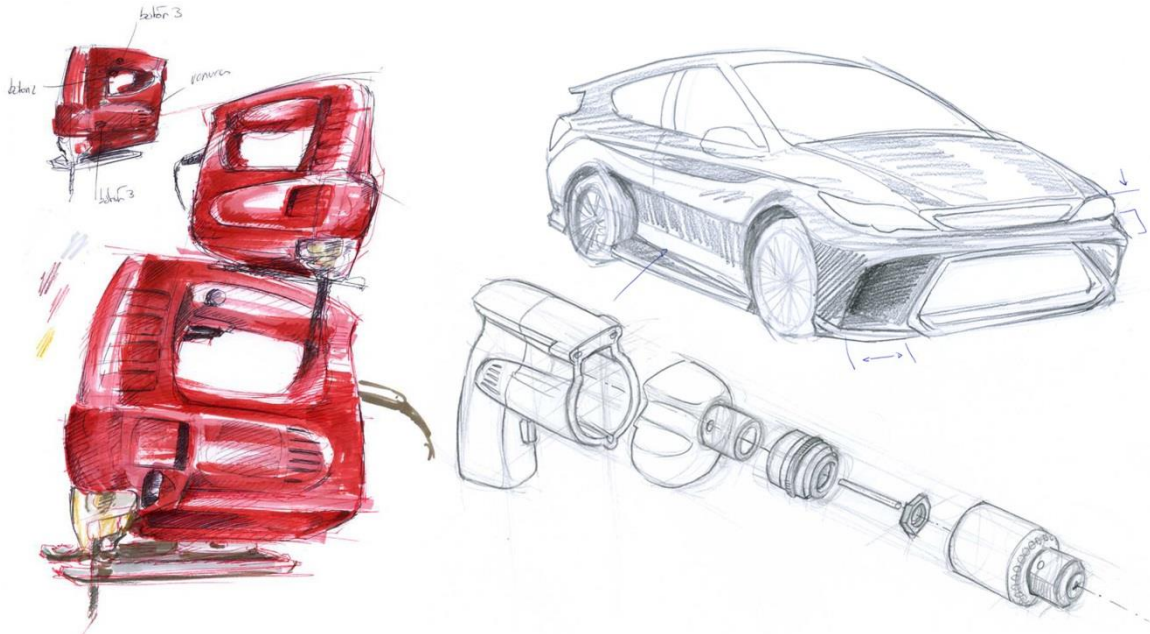


Figure 3. Graphic sketches of a student of the subject (Laura Zas): conceptual representation of various industrial products.

3.2 Reflection and self-evaluation

After the course, students were asked anonymously to rate on a scale from 0 to 10 points the level of improvement they considered had reached during the subject in the analysis and expression of everyday objects by drawing, over the previous year. 80 students of 100 enrolled answered: 49 reported having improved their skills and 31 said they did not consider to have improved (see Figure 4).

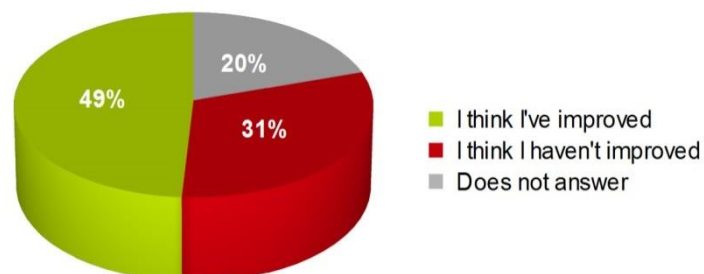


Figure 4. Students' perception on the improvement of their skills at the end of the course

In the survey the students were also asked to objectively assess the ability of expression they thought they had reached at the end of the course, assessing their overall skill, the visual quality of their work and the adequacy of strokes. The average mark of the students on their own skills was 7.21 points out of 10, which was very close to the actual average grade achieved in the course: 7.0 out of 10. This fact corroborated that they had acquired the ability to be critical of their own work and evaluate it according to objective criteria, learned by using rubrics during the course.

3.3 Performance and overall results

The subject was successfully passed in the first round by 93 of the 100 students enrolled. The average mark was 7.0 points out of 10, the lowest mark was 5.1 points and the highest 9.5 points (see Figure 5). The attendance was very high throughout the course, which reveals a very high interest by students in this area, a finding consistent with the answers to the second question of the survey conducted at the beginning of the course.

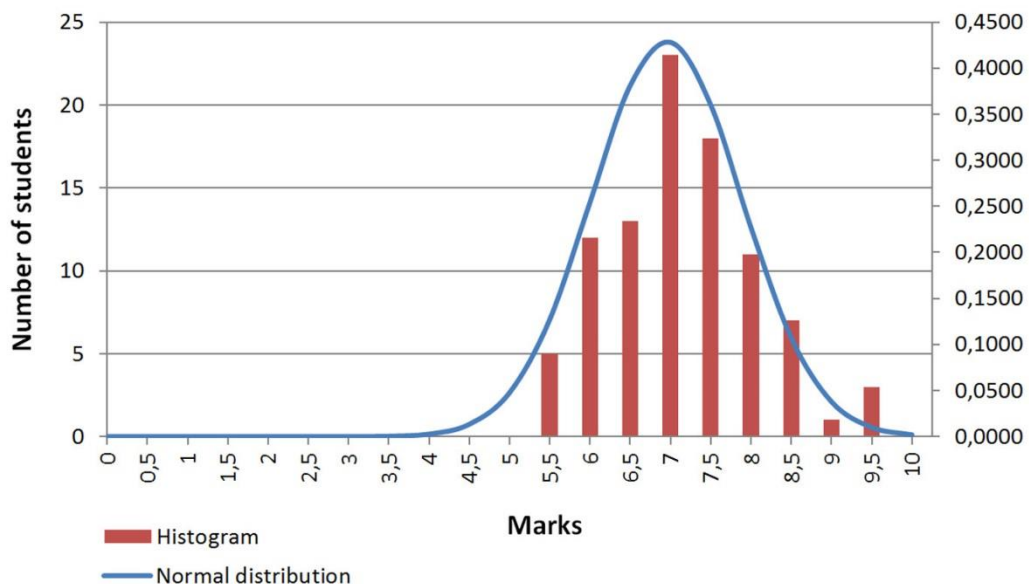


Figure 5. Normal distribution of marks.

4. Conclusions

The methodology implemented in this subject has shown positive results. Direct observation of many real industrial products, to become familiar with them through their manipulation and tactile experience have proven effective for students to understand their particular formal geometry, the first step in learning to represent them without copying, during the design process of similar products. Using different drawing tools and techniques for quick hand representation has allowed the students to learn express themselves through various graphic languages, helping them learn to choose the one that best suits each time.

The exercises implemented and their sequence during the course have allowed almost all students achieve the desired competencies satisfactorily. It is worth mentioning that students who did not pass the subject was because they did not come to class or did not perform any of the exercises. This confirms that the methodology implemented allows achieving the necessary skills to all students of the Degree in Design regularly attending classes, regardless of their previous education.

The first observations carried out on the subject 'Model making workshop', which is taught following 'Artistic Expression II', verify that the students already draw with more ease than students from the last year, representing their ideas for new products quicker and with greater skill. However, closer observation is desirable to see if these skills are maintained or improved over time, and quantify the long-term impact that this methodology can have on other related subjects of the Degree, in order to identify potential areas for improvement.

5. Acknowledgment

The methodologies conducted in this subject are part of the educational improvement project with reference 3049/15, which has received funding from the Educational Support

Unit (U.S.E.) of the Jaume I University, through the annual program 'Aids for educational innovation projects at the Jaume I University in the 2015/16 course'.

6. References

Carnevale, V. (2015) "To Design" or "To Draw": Two Different Verbs, Two Different Abilities, One Result. *The International Journal of Designed Objects*, 8(1), 17-25. <https://doi.org/10.18848/2325-1379/CGP/v08i01/38695>

Dong, H., Selami Cifter, A. & Fan, Z. (2013) Methods for Improving Undergraduate Students' Sketching Skills. *International Journal of Mechanical Engineering Education*, 41(nº4), 329-336. <https://doi.org/10.7227/IJMEE.41.4.7>

Herbert, D.M. (1988). Study Drawings in Architectural Design: Their Properties as a Graphic Medium. *Journal of Architectural Education*, 41(2), 26-38. <https://doi.org/10.1080/10464883.1988.10758473>

Laseau, P. (2001). *Graphic Thinking for Architects and Designers*. New York: John Wiley & Sons.

Travis, S. (2014). Sketching as a Tool for Seeing: A Method for Teaching Drawing to Architecture and Interior Design Students. *The International Journal of Design Education*, 7(3), 63-74. <https://doi.org/10.18848/2325-128X/CGP/v07i03/38452>