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Some ideological considerations in the Bauhaus for the development of didactic activities: The influence of the Montessori method, the modernism and the gothic☆

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ABSTRACT

The way in which Industrial Design confronts materiality and transforms it into products of use, obeys influences that are not always scientific. From its origin, artistic movements, ideologies, culture, technology and market demands, among many others, have continually modeled its epistemology and phenomenology. The Bauhaus, established a conception of Design almost a century ago but that is still valid in Latin America, even though its extreme dogmatism was the cause of its decline. In this opportunity, we review the influence of the Gothic, the Montessori pedagogy, the ideologies of the late nineteenth century, intuition and modernism, as central aspects in the original didactic and with it we have developed a simple classroom exercise, where they apply to identify the original elements that still prevail in the teaching practice of Design. These influences tend to be forgotten, but they have evolved since 1919, until decanting in the "Design Thinking" method, which, with the filters of contemporaneity, has put the own way of "thinking and doing" of the design at the disposal of other disciplines.

1. Introduction

Industrial Design is about to celebrate its first century, since it originated in Germany in 1919. Its didactic methods and the rationalist approach proved to be an innovation in the higher education oriented to the industry. However, over time the sense that gave rise to the methodology of teaching and especially the context where it occurred was lost. Currently the method is replicated, without further considerations, under the name of "Design Thinking" which, originated in the United States in the 1970s, reduces the method only to a process that focuses creativity towards the generation of an innovative solution to some problem Although there are detractors, it has been seen as an efficient methodology (Uysal & Topaloglu, 2017) but the Bauhaus was much more than that and the intention of this work is to remember that particular approach, where it was considered that not all knowledge is epistemic, but gnostic vision and pre-cognitive processes are also influential.

Once the central elements of the Bauhaus didactic were identified, an exploratory activity was proposed, whose purposes were two:

1. Verify if the foundational elements of the Bauhaus didactics could be useful in the contemporary didactics of Design, even though the contexts are very different.

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2. Verify if the exercise could also be implemented to engineering students, after a brief creative induction, incorporating the same didactic elements.

In relation to the latter and as a hypothesis, it was suggested that, if engineering students were given a creative induction, they would be more intuitive in making decisions.

From the study of both the founding manifesto and the available literature, about the origin of the Bauhaus didactics and the exercises and classroom activities, we have identified the four central variables that gave rise to the didactic model:

1. The Gothic influence;
2. Modernist pedagogy and rationalism;
3. Intuition
4. The ideology;

1.1. The Gothic influence

The teaching of Industrial Design and the way of facing the materials,[1] originates in Europe, in a time of changes marked by the influence of Victorian "medievalism", the beginning of the workers' movements, the rise of capitalism, neo-colonialism, industrialization accelerated, mysticism and rationalism, all in a time of relative peace, known as Belle Epoque.

As is known, the industrial era began in the late eighteenth century, with the introduction of steam power that drives the machines, which in turn replace the muscular force. With industrial manufacturing, artisans could not intervene directly in the processes, because many of these were simultaneous and had to be planned. The once individual work became collective and the artisan stopped making the complete production process, specializing only in one task. From that specialized craftsman, urged to work collectively and to plan production processes in series, directly derives the industrial designer.

The origin of contemporary design, recognized in the Bauhaus of Weimar,[2] had in the neo-Gothic,[3] a decisive reference because of the revaluation that was made of it in Victorian England[4] in the late nineteenth century. In that period the most technologically advanced nation was England, while Germany maintained a position of second importance, but with the interest in achieving greater prominence after its unification and subsequent birth of the German Empire in 1871. Because of this, a series of visits by German experts to England to learn about the style that gave great success to industrial production. This resulted in the creation or reformulation of the German arts and crafts schools beginning in 1896 (Droste, 2006).

In this context, Walter Gropius[5] visits England at the end of the 19th century and meets William Morris, together with the Arts and Crafts movement. Morris, of socialist orientation, exerted a great influence on this movement and gave him a political sense, situating it as the expression of an action of resistance against the machine. Mainly due to the negative consequences for workers of accelerated industrialization and the rise of capitalism (Kennedy, 2008). For Morris, the medieval cathedral was a symbol of joint work behind a unique ideal and declared the harmonious union of craftsmanship with man (Kennedy, 2008). In this way, the movement promoted the return to medieval production and the revaluation of craft trades and guilds.

In Germany, the Arts and Crafts made a lot of sense and medievalism was based on German Gothic, because the way of producing that was proposed made direct reference to medieval workshops and artisan guilds. This is how the Gothic was re-valued by them as an element of identity and national unity, towards the beginning of the 20th century (Droste, 2006). The Gothic, has its origin in northern Europe and the Goths (Germans), who cultivated it, were a people whose epic of resistance in defense of their freedom against the Holy Roman Empire, was a metaphor very appropriate to the contingencies of the Victorian age, between colonialism and independence. Therefore, in the German case of the early twentieth century, Gothic was a political and nationalist reference, but not necessarily aesthetic (Brooks, 1999).

The Gothic style, strongly expressive, luminous, naturalistic and humanistic, was also constituted in a good metaphor of rebirth and elevation, propitious to the historical moment. However, the Gothic would soon find the modernist movement (Jugendstil) and the theories of Worringer (Gómez, 2008) who postulated that the tendency in art, since antiquity, is to evolve towards linear abstraction and this also included the Gothic. The psychological and scientific vision of art that Worringer sustained, which, according to him, originated in the artist's emotional and expressive tensions (Kaufmann, 2008) would also help to create the Bauhaus own style, which finally tried to reconcile art with the machine.

During the Gothic, artisan workshops were grouped according to the trade, in highly regulated guilds (Stabel, 2007), which were located close to each other, whose quality and ethics were supervised by "jury guardians" or "juries" (Sears, 2006). A workshop could elaborate objects of use, while others were dedicated to art, not a few those who were dedicated to the production of artifacts of use, made by artists. The internal organization was very hierarchical and there were three levels; teacher, officer and apprentice, all with specific requirements to move from one to another. The Master was the expert in the trade, who belonged to the guild and had given evidence of its quality before a guild council and it was not strange that it received awards and had great prestige in terms of its

[1] We establish the distinction between matter and materiality, where the scope of work of the Design refers to the materiality or, in other words, to the materials that adapt to industrial processes and not to the raw material.
[2] That in its origin it was a school of architecture and arts.
[3] Style also uses Itten in his workshop.
[4] Neo-Gothic or medievalist movement.
[5] Walter Gropius, architect and founder of the Bauhaus School, considered the originator of Industrial Design.

excellence (Izquierdo, 2014). Who was still in the structure, was the officer, who was an expert and salaried of the Master and could also ascend to the category of Master, through the production of a "masterpiece". If the Master approved the work, the officer could set up his own workshop, give his evidence to join the guild and pay the amount of money required for it. Finally, the apprentice was a boy to whom the Master taught him the trade, lived in the workshop and did not receive any remuneration, but he did not pay either; the apprentice could ascend to the category of official, after four years in the hierarchy.

That structure was taken over by Gropius and from then on, the training of designers has followed a course that in its essence has mutated little, but that usually forgets the medieval workshop as the key precedent in contemporary didactics and that finally gave rise in 1919 to the "Design workshop" or Vorkurs. In it the apprentices worked next to a Master who, by means of the use of tools and machines, transform the matter for the accomplishment of a collective work. However, for the Bauhaus, the Gothic was also only a symbol and a metaphor of egalitarian group work based on a common ideal, but not a source of stylistic inspiration. This matter was expressly pointed out by Gropius, who, however, did not prevent the school method from being defined as "a systematic way of inventing style" (Le Masson, Hatchuel, & Weil, 2015).

The discourse of Gropius, who also sought to recover the trades and remove art from isolation (Kennedy, 2008), led to the founding manifesto of Bauhaus (Rivera, 2009), which proposed a new productive scenario in which the machine, now inside of the factory, produced objects in series (Argan, 2006), in an amount much higher than the capacity of a craft workshop and its hand tools.

1.2. Modernist pedagogy and rationalism

Bauhaus training was based on experimental work and method, originated in rationalist models, which proposed "learning by doing" (Ascher, 2015) especially the Montessori method (Moholy-Nagy, 1963), which resulted decisive in the origin to the "Initial Design Workshop" or Vorkurs; contribution that has also been maintained up to the present. The method devised by María Montessori originated in her work with children with mental deficiencies and physical disabilities (Obregón, 2006) and after a while, she directed all children between three and six years old. The first approach of Industrial Design to the transformation of matter is analogous to how children do it, where intuition, imagination, fantasy and creativity are the basis of training.

The "Initial design workshop" had a format like that of kindergarten, with parties and games, where only the projective meaning of the solutions changed, however, this could seem extremely free, seeking as a final objective to link the art with science and technology, through practical experience and the development of conceptual thinking. Without going further, modernism becomes rationalism, which in turn is a movement of ideological resistance (Camacho, 2005). In this way, the drawing conceived as a pedagogical resource to awaken the expression in the child, will then be transformed into an instrument for industrial training (Bordes, 2007). This functional feature of the drawing was also shared by Steiner in the Waldorf schools (Rose & Jolley, 2016), which nevertheless had as their purpose the creative, imaginative development of the child and not only the capacity for representation and expression.

Likewise, the rationalist origin of Design comes from the positivist movements of the nineteenth century, which place reason as the distinctive element of the human condition, which distances it from the religious and allows all men to be on the same level of equality, while the concept of progress is necessarily associated with the material. This allows to understand the empirical and therefore rational component of Design, which nevertheless has opened spaces for the aesthetic dimension, not only for the conception of beauty, but for the inevitable semantic value of the objects; an apparent contradiction, which until today is close to discipline. However, under modernism the concept of "faith" continued to exist, even though the rational and material was demonstrable by reason and faith was not, while "progress" is measurable in the economic and therefore projectable in the time.

The formative curriculum of the Bauhaus was organized in seven concentric circles, which contemplated a gradual technological evolution from the utensil to the machine and intended the student to know the reality of the matter, through experience. The first of those circles (Fig. 1), the most external, was the initial workshop, then there was a rather theoretical circle and finally, successive circles that were organized in materials and materials; wood, metal, fabrics, color, glass, clay, stone, considered as preliminary steps to reach the central circle, the product or "work" (Rivera, 2009). However, the dogmatism of the Bauhaus led to almost "religious" limits industrial work, which as the goal sought the domain of matter by the spirit, to achieve the "standard" (Argan, 2006).

Broadly speaking, this approach to practical work continues today, with some changes in the (ideological) approach and in the typology of the materials, but maintaining the increasing sequence of difficulty in the transformation of the raw material, which becomes material (Manzini, 1993), until materialization (Aish, 2005) in the form of a product. This is how it happens, for example, with paper, wood, metal, plastics, composites, in terms of materials. And on the other hand, to the use of the tools, hand tools, power tools, bench machines, automatic and numerical control, in terms of production processes. The same criteria about materiality and experimentation have now given rise to the "Digital Bauhaus", which also has a link with the material, but from the perspective of emerging social needs, participation and social creativity, where the focus from the group towards the collective (Gislen, Harvard, & Hellstrom, 2009), further expanding the egalitarian ideas promoted at its origin.

1.3. Intuition

It is an accepted fact that not all the knowledge of Design comes from the scientific, despite the different functionalist manifestos, on the contrary, an important part of them comes from humanistic and even esoteric[6] aspects (Zeinep, 2009). The attitude towards

[6] Like the Mazdaznan exercises, from Itten.

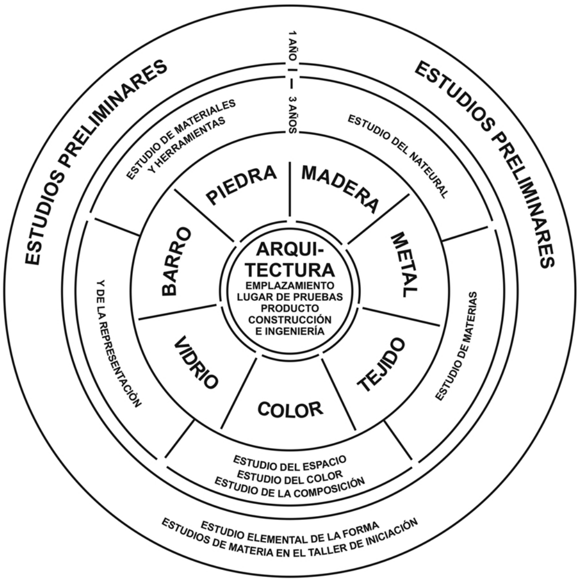

Fig. 1. Circular model of the Bauhaus curricular structure Source: own elaboration based on the original diagram of the year 1922. Fig. 1: Circular model of the Bauhaus curricular structure Source: own elaboration based on the original diagram of the year 1922.

the transformation of matter also reflects these nuances, which go beyond the use of the material itself, since they connote it as symbolisms; moreover, the etymology of the design tells us that the origin of the term comes from “designating” which is nothing else than representing with signs.

Thus, belief systems and foundational myths, which do not belong to scientific knowledge, have been fundamental for the transformation of matter, because “form” is nothing other than a particular degree of this (Argan, 2006).

The current classification of Design within the Humanities,[7] tends to confuse the didactics of a discipline that also solves emotional problems in a technical way; nevertheless, when speaking of humanities, we refer to the broad meaning of the concept, which embraces the whole culture, including myths and beliefs and, of course, religion. This last detail, adds the Gnostic dimension (Zeinep, 2009) that complements the episteme, forming a particular combination, sometimes contradictory, that despite this is capable of giving body to the discipline. This is a relevant fact that establishes the scope of disciplinary action, regarding the origin of knowledge and reaffirms that this is not entirely scientific and therefore Design as a cultural actor (Buitrago & Duque, 2013), cannot ignore it, because to deny this aspect is to ignore its broader human sense.

Intuition, understood as the generation of an instantaneous knowledge through perception, was treated in a deep and experimental way by the Bauhaus, mainly in the teaching work of Itten, who also intended that his students reach full consciousness of themselves, in a process of personal development with clear Hindu references. It is not unknown the fact that Anthroposophy exerted influence over Itten and Kandinsky, in the first Bauhaus and even Steiner's pedagogy, spiritual and scientific (Mezentseva, 2016) which in turn was inspired by the ideas of George Gurdjieff. Without going any further, Gropius himself adopts the idea of “New Man” by Franz Muller-Lyer and includes sociology within the curriculum (Proppelreuter, 2011).

Itten’s workshop,[8] perhaps the most influential to date, recognized “intuition” and “method” as the opposites that shaped the pedagogical experience of learning, which was complemented by “subjective experience” and “objective recognition” (Droste, 2006). In this way and through the contrasts, it was intended to refine the “sensitivity of students to the material” (Moholy-Nagy, 1963).

During the first year of studies, perception, sensitivity, sensory experiences and intuition were fundamental, as a readiness to domain material and that approach, despite criticisms of the influence of Gestalt (Uysal & Topaloglu, 2017), has prevailed until today. Moreover, the didactic of the “Design Workshop” arises as a reaction to the training that students previously received in school and the prejudices with which they reached the first year. On the other hand, Moholy-Nagy recognized that not all works originate consciously (Moholy-Nagy, 1963), as well as the impossibility of perceiving it in all its complexity in this way. However, the conscious allows to systematize the intuitive and this consideration helped to outline the exercises about the matter, its properties and its finishes. In them, experience was crucial, but it had to be rationalized later, a process that is currently contained in the concept of generativity (Le Masson et al., 2015).

1.4. The ideology

The “factory” was at one time a symbol of progress that would nevertheless transform society and grant the worker a new

[7] According to UNESCO.
[8] Johannes Itten, painter and one of the first teachers of the Bauhaus.

category in the human structure. However, the Protestantism that directly influenced the Industrial Revolution (Weber, 2003) and the rise of capitalism, also did it with the Industrial Design, which, of Anglo-Saxon origin, was not alien to these influences either.

Although Gropius made extensive efforts to keep the Bauhaus away from contingent politics, in a "romantic anti capitalism" (Kennedy, 2008), it was the paradox itself of the nature of its conception, that which impeded it.[9]

The ideas of Gropius and Morris,[10] were essentially socialist and internationalist and this ideological nuance in the middle of a convulsive time, had the capital influence that allows to explain some characteristics of the discipline, emerged from the workers movements inside the factories and then they would bring him problems with the Nazi regime. Similar circumstances, repeated several times in the twentieth century and in each of those opportunities, Design jumped from one paradigm to another. If the end of the First World War helped to emphasize the production of goods, the postwar period in the United States led to an "explosion" in production and consumption. On the other hand, in Europe, the democratization of access to goods facilitated reconstruction and once again constituted a gravitating political factor. For all this, it is not strange that the politics and the state programs, condition the use of the matter because for centuries this has happened and the Design, from its political perspective, is not alien to this phenomenon either. Moreover, from time to time, the governments of different countries organize activities to promote the use of certain commodities, look for replacement alternatives or stop using this or that material, for strategic reasons.

Therefore, serial production and Industrial Design were leading agents and eventually signs of progress in this period, to the point that several Latin American governments, including Chile, introduced it centrally (Castillo E., 2010). By the way, the crafts were already part of the Chilean educational system since 1849, with the School of Arts and Crafts, which promoted the cultivation of the "mechanical arts" in:

> "The children of honest and industrious craftsmen". (Castillo E., 2014).

In the same way, the Federico Santa María Technical University,[11] founded in 1930, expressly stated in the testament of his benefactor:

> "… put within reach of the meritorious destitute, reach the highest degree of human knowledge; it is the duty of the wealthy classes to contribute to the intellectual development of the proletariat " (Santa María, 2016).

Consequently, we must remember that from its origins,[12] the Design does not belong to the tradition of the ruling classes, also known as "idle class" (Veblen, 2005), cultivators of the humanities and the fine arts, but rather to the " industrial class ", which deal with trades or also the so-called "mechanical arts" and even "vulgar arts" (Tatarkiewicz, 1997).

2. Materials and methods

2.1. A practical exercise

To verify how the variables identified in the Bauhaus didactic could be considered, for the transformation of the material, in the development of a very simple exercise. We have raised one almost obvious, which has been made in the prototype laboratories of the Faculty of Architecture of the University of Chile. In this transversal activity, students from the Industrial Engineering career (ENG) and students from the Industrial Design career (DES) participated.

In simple terms, we have emulated a didactic activity like that carried out in a Montessori kindergarten and which, as we have said, is the basis of the "Design Workshop" that, as a result, seeks to strengthen logical thinking. It was proposed that, through the collective work between the students and the teacher, a planned activity be carried out in an experiential and creative way, as was the intention in the Bauhaus where intuition and spontaneity (Aish, 2005) were relevant, in the conception of Design.

It was considered to strengthen the empirical knowledge of the wood and of some processes that can transform it, together with the physical perception of some consequences of the mechanical work actions, such as the effort, the smells, the vibration, the noise, the detachment of chips, texture, among others.

The activity consisted of randomly drilling a piece of wood and then, with only two cuts, dividing it into three parts, where each piece weighed the same.

All the groups were given a piece of wood, with a square section of 50 mm per side, which they then had to drill. Then, these pieces, already perforated, were distributed randomly among all the groups. The idea is that each group had a different piece of wood than the one they had drilled.

The rules were very basic, so that the interaction was explorative; this was done to prevent the "experiential"[13] ignorance of the material (Uysal & Topaloglu, 2017) to induce the student to behave prejudiced before him. The group discussion led to the elaboration of conjectures for making the final decisions about where to cut, which despite having an intuitive origin were subsequently measured. As occurs in a design project where intuitions, will give rise to hypotheses that will then be subjected to a logic system and evaluated in their feasibility.

[9] Paradoxically, Gropius ends up working in the United States.

[10] William Morris, English architect, founder of the movement called Arts and Crafts, considered a forerunner of industrial design.

[11] Whose architectural design is neo-Gothic.

[12] Fine art is considered to be painting, sculpture, theater, literature, dance and architecture. There are also those who refer to cinema as the seventh art.

[13] It is important to highlight this fact, since the use of 3D and simulation technologies have distanced the student from the material reality; we know what wood is, its mechanical properties and its costs, but the wood itself is not always known.

Fig. 2. Collective work guided by the teacher. Source: own elaboration.

Before starting the activity, engineering students were given a brief induction into creative and intuitive work, like that received by designers

2.2. Populations and samples

We worked with 10 groups of students, divided into two populations: Industrial Design (DES) and Industrial Engineering (ENG). Each population consisted of 5 groups of students and in turn each was composed of 3 or 4 people, giving a total of 36 students, which corresponded to the total number of students participating in the subject. In this case, the universe and the sample have the same size.

As for the piece of wood, they all had the same section, but different length. This was done to avoid the temptation for one group to observe another and try to replicate the cuts, due to the natural uncertainty produced by an exercise with clear rules, but with little complementary information.

Because of this, the measurements were made based on percentages of weight of each piece and not directly on the weight of the pieces, otherwise the measurements of standard deviation would necessarily be larger in the larger pieces.

2.3. Variable 1. Gothic influence

“The collective and planned work of the students, who together with the teacher transform the subject, thanks to the will”.

All groups of students were asked to take a piece of wood and drill it with bits of different diameter, as many times as they wanted (Fig. 2).

To be an exercise on the subject, recognizably inspired by the Bauhaus didactics, you must necessarily consider the participation of the teacher, who demonstrates, guides and explains, but above all serves as an example to the students' experience. This activity, with the presence of the teacher, is equal but not democratic, due to considerations of industrial safety.

2.4. Variable 2. The modernist rationalist pedagogy

“The construction of knowledge through play and fantasy”.

An exercise of this type must also have a playful sense with clear rules and a “script” that must be articulated by the teacher (Fig. 3). Students must measure and formulate rational explanations to strengthen the capacity of conceptualization and logical thinking, to start the discussion about the best way to make the cuts and the development of conjectures to finally achieve a measurement, as accurate as possible.

2.5. Intuition: “instant knowledge through perception”

Once the wood is perforated, it is given to another group, who divides it intuitively into three pieces by means of two straight cuts, so that the weight of each piece is similar (Fig. 4). To separate from the rational judgment in the stage of defining the cuts, students

Fig. 3. Measurement process and conjecture elaboration, based on empirical data. Source: own elaboration.

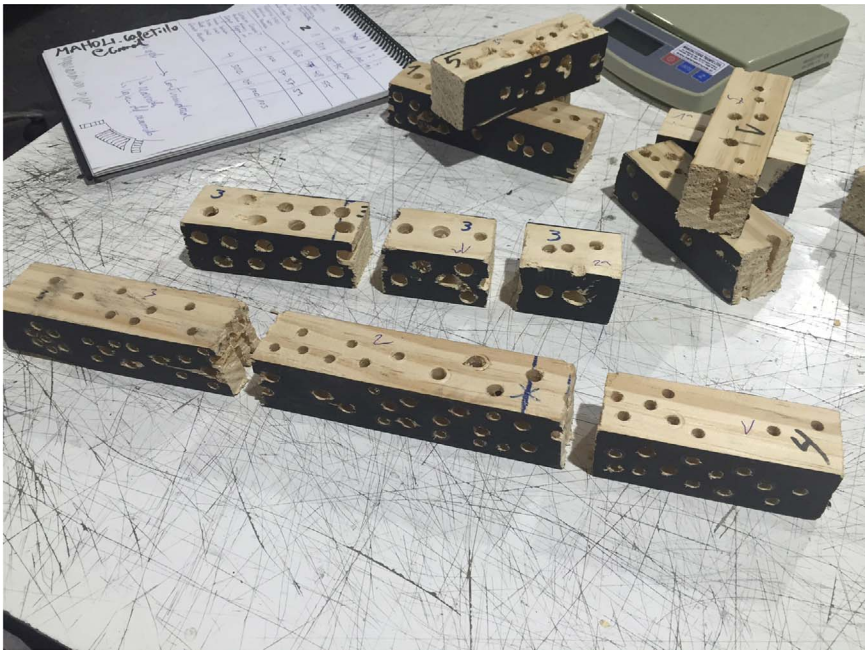

Fig. 4. Cut and perforated pieces of wood. Source: own elaboration.

have five minutes. In this part you should not count the number of perforations or calculate the loss of material (weight) that the perforations are producing. It is important to emphasize that this forces a spatial analysis of the form and a visual journey, forcing them to think three-dimensionally.

2.6. The ideology: "standardization and the search for the average"

Students must recognize and measure the "error" to determine the deviation from the standard and the average obtained by all the working groups. This is the quantitative part of the exercise, at which time the validity of intuition and its ability to stimulate the elaboration of conjectures are discussed. This allows us to recognize from the experiential exercise, that all scientific research is born

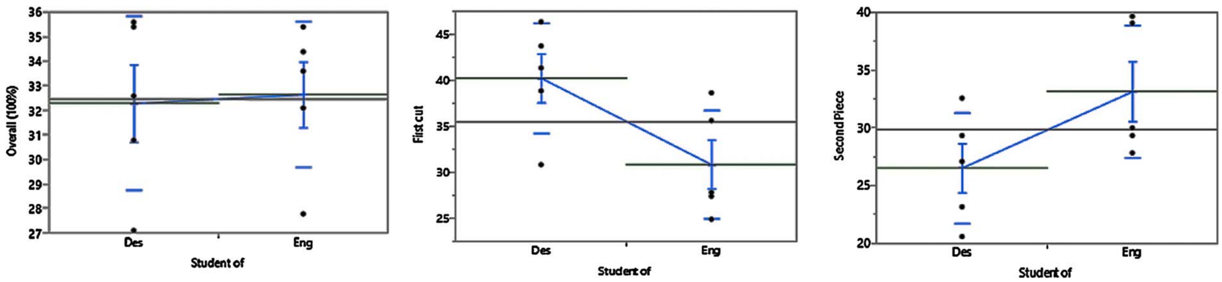

Fig. 5. One-way Analysis. From left: Overall (100%), first piece and then second piece, by Student of Design and Engineering Source: own elaboration.

from an intuition and the search for the average, evokes the mass production and finally the access to goods in an equitable way.

3. Results and discussion

Statistical analysis was applied to the results of the different groups and for this the unpaired "Student's *T*-test" or for independent samples was used, however, the sample sizes were small (less than 15, which made it difficult to validate normality of both samples, and therefore we cannot speak of conclusive evidence but of an experimental study of approximation to the studied problem. The test seeks to establish if the null hypothesis is valid (that there are no statistically significant differences between the results obtained by designers and engineers) or if the null hypothesis is rejected (that is, if there are significant differences or, in other words, if the experiment is repeated many times, the differences will continue to occur).

The tests performed for the first and second pieces, although they have the same problems as those previously described, show a trend towards the existence of statistically significant differences between the designers and the engineers, both in the first and second cuts, but with results inverted between one another, that is, with higher averages for the designers in the first cut and with higher averages for the engineers in the second cut (Fig. 5).

No atypical or unusual data were presented between the two populations under a first visual analysis, however, in a later experiment with larger samples this must be verified in a specific way. But there are significant differences between the first and second cuts of the piece of wood. In the first cut, the engineering groups tended to be more exact, with a minor deviation and closer to 33%, which should correspond to one third of the total weight of the original piece, however, they lost precision in the second cut (Fig. 6).

According to the results obtained in this test t on the whole experiment, there are no significant differences between the results of both student populations (Tables 1–6).

In contrast, the design groups were more accurate in the second cut, with less standard deviation in relation to the exact third of 33%. Although it was not a measured variable, it was found that the time for making decisions was different in both cases; The first cut in the engineers took more time, just the opposite as in the case of the designers.

4. Conclusions

The "method" of Design, which originates in an ideological, convulsive and violent era, has become almost a foundational myth, repeated by generations of designers. The theoretical sustenance that supported the modernism, oversees conditioning the social ways of transforming the matter. Therefore, doing it from the Industrial Design is a complex issue that covers all spheres of human knowledge, whether scientific or not. Although the focus of this article is on the Bauhaus legacy, we have confirmed its full validity, both in form and substance; Moreover, most industrial design schools in Chile and a large part of South America follow the same model.

One of the reasons for this validity, is that the introduction of Design in Latin America is due to State initiatives, therefore, political reasons very similar to those of the early twentieth century in Europe and that occurred in the 1960s in this continent.

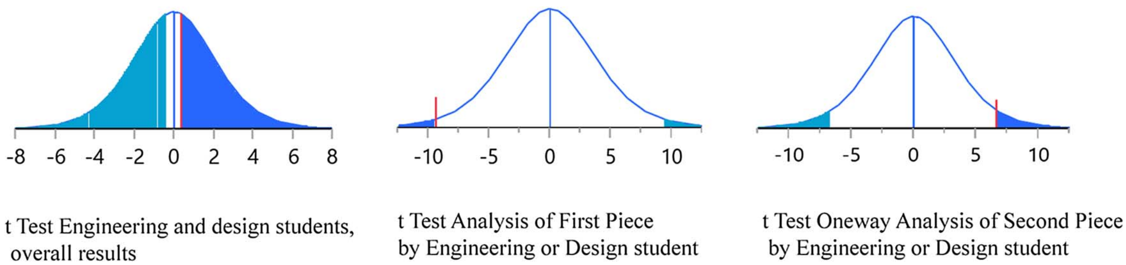

Fig. 6. *t*-Test Engineering and design students, overall results, then first piece and then second piece.
Source: own elaboration

Table 1
Means and Std Deviations, Overall.
Source: own elaboration.

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Des	5	32.3000	3.53129	1.5792	27.915	36.685
Eng	5	32.6600	2.97288	1.3295	28.969	36.351

Table 2
Means and Std Deviations, first piece.
Source: own elaboration.

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Des	5	40.2600	5.97645	2.6728	32.839	47.681
Eng	5	30.8600	5.89983	2.6385	23.534	38.186

Table 3
Means and Std Deviations, second piece.
Source: own elaboration.

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Des	5	26.5600	4.77211	2.1342	20.635	32.485
Eng	5	33.1800	5.73733	2.5658	26.056	40.304

Table 4
Assuming unequal variances **ENG-DES.** Overall.

Difference	0.3600	t Ratio	0.174388
Std Err Dif	2.0644	DF	7.77413
Upper CL Dif	5.1446	Prob > |t|	0.8660
Lower CL Dif	−4.4246	Prob > t	0.4330
Confidence	0.95	Prob < t	0.5670

Table 5
Assuming unequal variances **ENG-DES.** First piece.

Difference	−9.400	t Ratio	−2.50287
Std Err Dif	3.756	DF	7.998668
Upper CL Dif	−0.739	Prob > |t|	0.0368*
Lower CL Dif	−18.061	Prob > t	0.9816
Confidence	0.95	Prob < t	0.0184*

Table 6
Assuming unequal variances. **ENG-DES.** Second piece.

Difference	6.620	t Ratio	1.983601
Std Err Dif	3.337	DF	7.743092
Upper CL Dif	14.361	Prob > |t|	0.0838
Lower CL Dif	−1.121	Prob > t	0.0419*
Confidence	0.95	Prob < t	0.9581

Despite this, the necessary updating of the Bauhaus didactic is evident, adapting the current complexities, but giving answers to the same needs, only with different manifestations.

It can be said that the way of facing matter is practically a "philosophy" of Design, which has overcome the technological changes and to which the discipline has been able to adapt. Thus, matter is more a "possibility" than a support of the form; a "provocation" to creativity. It is very likely that the complexity of the discipline is maintained or even increased over time, essentially by focusing on human phenomena and not necessarily on technology, to solve the usual problems and emerging ones. Likewise, it is also very probable that the ways of transforming matter and materials, always in evolution, continue to obey factors of the most diverse influence, even contradictory or inexplicable. Moreover, all these elements are intertwined and sometimes it is difficult to separate them to carry out their analysis, but this reflects the systemic nature of the discipline.

The modeling of the design process, known as "Design Thinking", approaches in a way analogous to how Porter's "value chain" emphasizes the aggregation of value contributed by the processes that transform matter. However, it does not refer to the mental and spiritual processes with which this takes place. After all, the Design is only one, among the many actors of progress and even some debacles, that without being the most important, in one way or another has always been to the eaves of the consequences of the great historical moments.

Recently, the digital simulation of materials has overvalued the visual, to the point that the material has been reduced in our opinion to an extreme virtual representation or mere structural calculation. The above, which has come to replace the sensory perception of the material, and rapid prototyping has only deepened this situation, losing in some way the experiential or "experiential sense" of the interaction with matter and "learning by doing".

The exercise that was carried out proved to a certain extent that the variables that originated the Bauhaus didactics are still valid and that they could be independent of the historical context, because the essence does not change, but its phenomenology does. Regarding the measurement of the cuts, two profiles of approach to the problem were evidenced, that of the engineers, "Rational-intuitive" and that of the "Intuitive-rational" designers. Without being statistically conclusive, many questions are opened that point to the development of a typology of didactic exercises that encourage interdisciplinary work and whose effects also imply an increase in the "gray zone" at the intersection between both disciplines, where takes place the dialogue and the collaboration.

In the pedagogical has been noted, although there are studies that show beyond doubt, that students have lost sight of the initial technological stages in the transformation of matter, once delivered by school education. They usually arrive directly at three-dimensional modeling, losing sensitivity to matter. Perhaps it is because they have not traveled the historical path of artisans or craftsmen, rooted in thousands of years of technological culture and have made a great technological leap that has forgotten the intermediate stages.

It is possible that, in the future, this work originates a parametric method for the development of didactic exercises that are inspired by the modernist-rationalist education, which is permeable to historical moments, but above all maintains the ancestral spirit of the workshop of Design, as a foundational pillar of the way of doing, learning and thinking of the discipline.

References

Aish, R. (2005). From intuition to precision, Digital Design: The quest for a new paradigm. *23 nd eCAADe Conference proceedings.* 10–14.

Argan, G. (2006). *Walter Gropius y la Bauhaus.* Madrid: Abada.

Ascher, B. (2015). The bauhaus case study experiments. *Architectural Design,* 30–33.

Bordes, J. (2007). *La infancia de las vanguardias.* Madrid: Cátedra.

Brooks, C. (1999). *The gothic revival.* London: Phaidon.

Buitrago, F., & Duque, I. (2013). *La economia naranja: Una oportunidad infinita.* Nueva York: Banco Interamericano de Desarrollo.

Camacho, G. (2005). *Sociedad racional y educación: la génesis de la racionalidad educativa modernista. Revista Electrónica Educare*, *Vol. VIII*, Universidad Nacional de Costa Rica11–47 N° 1.

Castillo, E. (2010). *Artesanos, artistas y artífices.* Santiago: Ocho libros editores.

Castillo, E. (2014). *EAO La Escuela de Artes y oficios.* Santiago: Ocho libros editores.

Droste, M. (2006). *Bauhaus.* Köln: Taschen.

Gómez, S. (2008). *El afán de abstracción en la creación artística según Wilhelm Worringer. Imafronte*, *Vol. 19*, 285–304.

Gislen, Y., Harvard, H., & Hellstrom, M. (2009). The Everyday Poetics Of a Digital Bauhaus. In T. Binder, J. Lougren, & L. Malmborg (Eds.). *Re)searching the digital Bauhaus* (pp. 333–352). Springer.

Izquierdo, T. (2014). *Veedors, marquejadors, maestros: el valor de la experiencia en la carpintería medieval. El ejemplo valenciano. Anuario de estudios medievales*885–910.

Kaufmann, D. (2008). Pushing the lints of understanding: The discourse on primitivism in german kulturwissenschaften, 1880–1930. *Studies in History and Philosophy of Science Part A,* 434–443.

Kennedy, A. (2008). *Bauhaus.* Madrid: Edimat.

Le Masson, P., Hatchuel, A., & Weil, B. (2015). Design theory at Bauhaus: Teaching splitting knowledge. *Research in Engineering Design,* 91–115.

Manzini, E. (1993). *La materia de la Invención.* Barcelona: Ceac.

Mezentseva, O. (2016). *Conceptual ideas of spiritual and scientific anthropology of Rudolf steiner. Science an education*, *Vol. 10*, 220–227.

Moholy-Nagy, L. (1963). *La nueva visión y reseña de un artista.* Buenos Aires: Infinitos.

Obregón, N. (2006). *Quién fue María Montessori. Contribuciones desde Coatepec*, *Vol. 10*, 149–171.

Proppelreuter, T. (2011). Social Individualism walter Gropius an his appropriation of franz Müller-Lyer of a New Man. *Journal of Design History, 24*, 37–58.

Rivera, H. (2009). *Diez signos emblemáticos a propósito de los noventa años de la Bauhaus. De Arquitectura*15–19.

Rose, S., & Jolley, P. (2016). drawing development in mainstream and Waldorf Steiner Schools revisited. *Psychology of Aestetics, Creativity and the Arts, 10*, 447–457.

Santa María, F., (2016, 03 23). Universidad Federico Santa María. Retrieved from https://issuu.com/usmperiodico/docs/testamento_federico_santa_maria.

Sears, E. (2006). *Craft ethics and the critical eye in Medieval Paris*, *Vol. 45*, Gesta-International Center of Medieval Art221–238.

Stabel, P. (2007). Guild organisation and artistic production in Bruges at the end of the Middle Ages and the beginning of the Early Modern Period. *Moyen Age, 113*, 91.

Tatarkiewicz, W. (1997). *Historiaa de seis ideas.* Madrid: Teknos.

Uysal, V., & Topaloglu, F. (2017). Bridging the gap: A manual primer into design computing in the context of basic design education. *International Journal of Art & Design Education, 36*(1), 21–38.

Veblen, T. (2005). *teoría de la clase ociosa.* México: Fondo de cultura económica.

Weber, M. (2003). *La ética protestante y el espíritu del capitalismo.* Buenos Aires: Distal.

Zeinep, C. (2009). jugendstil visions: Occultism, gender and modern design pedagogy. *Journal of Design History,* 203–226.