How designers take in account tactual perception as a central, invisible phenomenon in the designing of industrial products

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Abstract: This paper presents the results of a research-action whose initial objective was to understand how the dimensions of what is sensitive are constructed during the design process in order to generate a model that allows the integration of the "perceived factors" in the design of industrial products. This work has revealed a tacit but primordial phenomenon in the construction of industrial objects: the phenomenon of tactility, which appears as an interesting concept in the current debate of the science of design, which appears above the analysis protocols of the design process. Tactility is an invisible phenomenon that is part of the register of bodily logic, that takes a crucial place in the local rationalities of the processes of design and use of the objects, and participates actively in decision making on the product's attributes.

Key words: Design process, Use process, Accountability, Tactility

1. Introduction

Even though it is true that reflection on the design process is not new, we can consider that since the 1990s, following the initiative of N. Cross and his colleagues, who created the first Delft Workshop in Research in Design Thinking [4,6,14], a science of design as such is emerging, i.e., a community of researchers, professors, and professionals in that field who started looking for common points of reference and language in an empirical field. Although it is debatable [5], most of these scientists recognize H.A. Simon [21] as the founding father of the science of design, thus revealing a common approach to design, considering it as a cognitive process.

Within the current foundational debate of a science of design, this paper presents an approach and a result, extracted from a research-action, that allow going deeper into this conception of the design process, reinserting corporality into the analytic approach and the practice of design. Although the design processes of industrial products in particular are studied, it seems appropriate to extend this view to other areas of design, considering the universality of the observed protocols.

So after a rapid state-of-the-art that allows positioning the proposed theoretical approach, the context, the methodology, and some results of the study are presented, placing particular emphasis in one of them: the phenomenon of tactility.

2. Theoretical Framework

2.1 The design process as a social, situated and embodied process

The increasing complexity of design projects has led to diverse interpretations and models to understand the design processes and products, inserted in different paradigms but supporting fundamental reflections for the science of design. Within this framework, with scientific rigurosity, the second Design Thinking Research Symposia of 1994 (DTRS2) used an interesting methodology by generating studies by various actors of the science of design on a same set of data. This experiment produced a first verification:

"Protocol analysis is somewhere in the middle 5 ground between the 'hard' experimental methods of the natural sciences and the 'softer' purely observational methods of the social sciences." [14].

Then, in 2007, Lloyd found that the workshops organized since then revealed a consensus of the scientific community of design on a concept or understanding of the design process:

"Designing is now thought of as a situated and social activity, as well as a cognitive activity, and in recent years a wide diversity of studies have looked at designing in a range of disciplines and used a number of methods including: interaction analysis (Tang 1990), computational linguistics (Dong 2005), viewpoint methodology (Detienne, Martin, and Lavigne 2005), semiotics (Medway and Clark 2002, Luck 2003), functional linguistics (McDonnell 1997), ethnomethodology (Hugill 2004), interaction process analysis (Gorse and Emmitt 2003), cognitive ethnography (Ball and Ormerod 2000), and discourse analysis (Reid and Reed 2005, Lloyd 2002)". [14].

The approach proposed in this article does not only consider design as a cognitive process and a situated social activity, but also as an embodied one. It also puts at the epicenter of its view the bodily condition, as the founder of all interaction of the process of building a material product, thereby following a phenomenologic view of perception [17]. This approach is also inspired in the ethnomethodological view [8, 9] and in the disciplines derived from it, like science studies [13], situated action [19, 22], distributed cognition [7, 11], and the embodied mind [15, 24], and therefore it considers design activity as a series of intelligent formal and informal procedures, based on cognitive[1] and perceptive mechanisms, that are developed by the members of a design team in order to make an industrial product emerge.

This involves considering that the design process is not just any problem solving, but it is above all a *material* solution of a problem – problem which is not only material–. While the design process is usually defined as a solution of ill-defined, complex, multiactor problems that accept various possible solutions and whose solutions are "satisfying" [21], the approach presented here considers also the particularity involved in the product's design solution, its material or physical condition that is at stake, leading to the involvement of the bodies that are interacting in the building of this type of solution.

Besides, it is considered that an industrial product, throughout the design process, takes on different statutes. In the first stages of the process, even though it does not exist, it is built as a natural object[2], i.e., a common sense object for the team members, allowing them to interact in order to construct it later as a material

[1] It should be stressed that it is commonly understood by most authors that cognitive phenomena involve the bodily being, and many times the analyses leave aside this bodily condition. For that reason a distinction is made here between what is cognitive and what is bodily, when strictly the new streams of cognitive science have shown the inseparability of both. Therefore, it is for intellectual convenience that these two terms are separated.

[2] To ethnomethodologists, an object is natural for those that use it when it becomes "a matter of fact", that is, an objetive entity shared by the subjets. Therefore, the context that has produced it becomes autonomous.

and cultural object, in other words a linkage object of some universe which, consciously and unconsciously, the team members generate.

It can also be said that the proposed approach does not deal with the design process as it has been considered so far by design scientists, but rather all the processes that allow a product to emerge as a cultural object are observed[3]. For that reason the industrial product is considered as the link of a world registered by its designers and rebuilt by its users, and for that reason it is considered that the design process does not end with the work of the designers.

2.2 The design is pursued in use

For decades, philosophers, sociologists, and ethnologists [1] have written on how we, the users, relate with the technical objects around us. As users, we transform industrial products into cultural and natural objects also.

But the ones that have expressed this phenomenon very well are ergonomists. In particular the ergonomists of the French-speaking stream, centered on activity [2], were the first to state that the design of a product does not end with the work of a design team, but sense continues to be created through the use given to the product. This statement arises from an ergonomic reflection on the predictability of the future activity (use) with technical devices. That is how Béguin reminds us that such theory comes from the 1990s, when Weill-Fassina et al., analyzing situations of instrumentalized activities, concluded that "the actions can not be reduced to an effect of responses to received stimuli, in a more or less passive manner […], the operator explore, interpret, use, transform the technical, social and cultural environment." [2].

Recently, Redström, through his call for a redefinition of the concept of "use" [20] applied particularly for some years in design with the User-Centred-Design current, reminds us that this theory of " design that is pursued in use" was translated at the design level as a recommendation to generate "unfinished things" [20]. In that paper, Redström is one of the few design thinkers that points at a restatement of the analytical approach of the design process, proposing to put at a same level of analysis the design process and the use process, –beside some authors that aim to generate design audit models [18] and make that analysis with a very operational approach–. Analyzing at the same time the design process and the use process of a product makes sense from the standpoint that these two processes are indissolubly related by the result of the design: the product. This reincorporation of the result within the analysis of the process seems indispensable to understand more deeply the ethnomethods developed by the members of a design team to build a product.

With this paradigm, a research was carried out in which analyzing the design process was extended to a study of the phenomenon of construction of an industrial product, considering the design practices that make it emerge as such as well as the use practices that make it live. This viewpoint led to the identification of a common construction logic of the industrial product: tactility.

3. Methodology: Research-action of two objects of daily life

3.1 A research-action of an industrial problem

[3] The cultural object of ethnomethodology is the couple consisting of an object and the interpretation of the object's history and function.

The study made starts from an industrial problem: ¿How can we generate products of high qualitative value that can compete efficiently in ever more complex markets where supply is exponential and the clients are increasingly more expert and demanding?

That is how, over the last 15 years, the perceptive dimensions are central to the success of an industrial product, and methods and instruments are developed to introduce a differentiation through not only functional but above all qualitative aspects, that is sensory, semiotic, morphological, and socio-cultural aspects.

Within this framework, since 1999 a research project was generated framed in a government program called Key Technologies that brought together an industrial group with several research institutions to optimize "the integration of factors perceived in the conception of industrial products" [1].

The research group consisted of engineers from a large industrial group producing home appliances, and of researchers and professionals from different fields: designers, semioticists, sociologists, design engineers, and the author, introducing the ethnomethodologic viewpoint.

The procedure adopted was to analyze products of the company that was part of the research group under the various existing approaches, in order to generate models that would allow an "integration of the aspects perceived by the consumer/user." Work was done in particular on a range of food processors (or culinary robots).

From an ethnomethodological standpoint, studying a product's "perceived factors" involves looking carefully at how the product is built, and more specifically at its qualitative dimensions, reading attentively the use processes as well as, in a more general way, the interrelations with the product, i.e., it involves studying the design process that generated the product's qualitative aspects.

From this perspective, the introduction of the ethnomethodological and phenomenological viewpoints involved looking closely at the processes through which the members of this research group constructed a reading of the perceived aspects in order to reach a design model of these aspects, in addition to participating in the construction of this model.

In this way, two processes whose only apparent similarity is interaction with a product were studied from the same viewpoint.

3.2 A look at "the product under construction"

Within this action-context investigation, the research methodology preferred by ethnologists, participating observation, could be experimented.

This methodology is fundamental to achieve an ethnomethodologic view that is aimed at observing things "as they are done" [9], allowing the observation of the intelligent procedures carried out by members of a community in a formal as well as an informal way in order to accomplish a given activity.

This participating observation methodology allowed, for example, the analysis of the informal procedures generated by the research team members to interpret the perceived aspects of a product, and made it possible to verify an "articulation between the finished boundaries of knowledge and significance and the sovereignty of our natural attitude" [1] based on a logic of bodies.

From the work done in the science of design [4,6,14], the participating observation methodology proposes a radical break at the methodological level. In fact, this methodology does not look for a systematization based on the rigurosity of hard science, as can be done with the method of "common data

analysis" [14], but it gives preference to the projects' variability, and therefore of the observed processes, stating as its objective to find invariable elements within this variability. That is how preference is given to fine and embodied observation (through participation), trying to reveal the natural and invariable attitudes of the community members in context, arguing that the laboratory exercises do not show all the complexity of these realities. It is thanks to this methodology, which places the scientific observer in the role of an actor of what is observed, that the most hidden processes could be identified based on a bodily understanding [1, 15, 24], such as product construction processes.

However, this methodology found a limit because industrial temporality restricts the possibilities of being able to follow the conception phase of a product as well as its diffusion and use phase. It was also necessary to rebuild in a retroactive manner the design process that led to the generation of the product that is being studied: the culinary robot, thanks to, in particular, the evidence contributed by a sociologist who could observe years earlier the design process applied in this company [3], and also thanks to the retroactive descriptions by the actors of this process.

However, to be able to apply the proposed view based on prevalence of the bodies in action, it was necessary to compensate for this methodological fault thanks to the "hic et nunc" study of the design process of another product, following the same research methodology of participating observation, which allowed a look at the product "under construction," in order to validate some conclusions extracted from the retroactive study of the robot. In this way, the study of the conception of a public transport seat made it possible to validate, complement, and extrapolate what had been observed with the culinary robot.

Also, the fact of studying the construction processes of two products from different fields made it possible to state the hypothesis that the results found can be extrapolated to other design projects of mass consumption products, taking into account the universality of the phenomenon of perception.

These studies, carried out according to a research-action approach, lasted four years from the time of development of each of the projects and the study of these experiences. This approach, based on experience (not only on observing but also on doing), led to revealing a phenomenon in which the prevalence of bodily logic, or sensitive logic, stands out in the design processes and in the use of industrial products.

4. Results

4.1 Accountability phenomena among members of the design process

A first conclusion of this research showed that the construction of the product's qualitative or perceived dimensions begins with the formation of the design team that will become the intersubjetive and interbodily space from which the product should emerge. It was seen that the constitution of the team is made by relations of belonging (which members are more pertinent to the project) and opportunity (which are the available members) that are given based on an interpretation of the project by some of the decision makers members. It was also verified that the team is constituted within an indexical relation,[4] i.e., members are sought within a field of directly or indirectly related partners. The constitution of the design group is fundamental not only in a cognitive interpretation of the design process, where one observes the collaboration mechanisms put in operation by the actors [12], whose viewpoints on the product, logic, and methods are different, but also from an

[4] The term indexicality refers in principle to linguistic expressions. Talking about the indexicality of a word or expression means that the sense given to it is always local, that is that it depends on the conditions of its enunciation.

embodied reading of the design process. In fact, according to this viewpoint one sees the importance of being able to generate a group that coheres progressively thanks to sensitive dimensions, becoming a "collective body" for the construction of the product.

That is why meetings, as shown by Hugill [10], have as their main goal to build a world of sense common to all the members in a situated but also embodied practice. This world is the basis of the intersubjetivity required for the emergence of the product. So, even though there are different semantic fields depending on each member's specialty, a common language is created in these negotiation spaces supported by the various convergence tools. For example, in the culinary robot project the engineers and designers that conceived it are based on a shared conception of the user and on the main function of the artifact, summarized in a scheme (called "the daisy" by the members due to the shape of the graph) that orients the later decision making throughout the design process. Therefore, the function of the robot according to this daisy, very often discussed at meetings, can be summarized as follows: "making sophisticated dishes without effort and without experience." This definition involves an almost Taylorist technical conception almost as much of the user as of the cooking act in which the robot must be inserted, and this conception oriented all the negotiations and decision making that allowed the emergence of the final product. This main function, established much earlier because it corresponds in general to all the ranges of this company's culinary robots, was never rediscussed throughout the design process, but it became a common sense definition to the members of the design team, thereby introducing, through its products, a form of relation into the act of cooking where a cold logic, a technical logic that excludes the sensitive relation prevails.

On the other hand, in the urban transport seat project it was seen that the design team members used various kinds of devices to succeed in generating a common language and world required for the product's emergence. That is how instruments like functional analysis, which attempts to put together the different competencies to define in functional terms the product to be designed, allowed the generation of the conflicts needed to clarify some key concepts like the term comfort, which was an important parameter for the design of the product. However, it is with much more discrete devices like whiteboards –as shown by Suchman [22]– and meeting-room chairs, that members' accountability mechanisms have been observed,[5] in order to generate not only a common language on the product to be designed, but to support the intersubjectiveness and interbodiliness required for the phenomenon of the product's emergence.

4.2 Tactility as a particular form of accountability and as the guideline between the design and use practices of a product

According to Garfinkel, accountability is an intelligent and natural method that the members of a community use to give themselves the common activities as "visibly-rational-and-reportable-for-all-practical purposes [8]. This method appears in the interactions of everyday life. The whiteboard, the meeting-room chairs, were the indispensable accountability elements that appeared in the public transport seat project and made it possible to give shape to the final product. However, the chairs in particular made it possible to reveal a particularity of the accountability mechanism. In fact, although ethnomethodologists often consider accountability as something specifically cognitive (i.e., that is generated from dialog, according to a linguistic

[5] "the ethnomethodologic studies analyze the everyday activities of the members as methods that make these activities be visibly rational - and descriptive- for all practical purposes, as an ordinary organization of daily activities." [8].

logic), the procedures followed by the actors of design with the meeting-room chairs belonged rather to a bodily field, that is, accountability in this case rather followed a logic of the bodies where the words only tried to express an understanding that all the members experimented perceptually with the chairs. This kind of accountability, which appears at the level of a bodily register, was designated by the term tactility to distinguish it from a visibility, as a strictly cognitive phenomenon, that corresponds to the mechanisms already highlighted by numerous ethnomethodologists.

With this perspective it was possible to identify a particular mechanism in the design process in which the team members not only make visible a reality from which the product can emerge, but also make this reality mutually tangible in order to generate the materiality of the product.

When making an ethnomethodologic reading of the interactions that were generated by the culinary robot, we meet again the same tactility phenomenon that had appeared during the design project of the public transport seat.

In fact, a careful analysis of a two-hour interaction of a woman with the robot (two hours during which this woman never succeeded in operating the robot precisely because of a mismatch with the assembly logic of the apparatus) allowed this bodily modality to be specified as a privileged interaction modality with these technical objects. It was seen that the understanding of the operation of the device took place within a bodily intelligence, by means of manipulation, and belongs to a cognitive field only insofar as there is some problem or mismatch that drives a manifestation of the acts carried out with the object. In fact, in the case of the culinary robot it is interesting to see that cognitive processes are more present in the cooking process than in the object itself, because cooking is a highly complex activity that requires hierarchization of the tasks, control of the processes, dosing of the ingredients, evaluating their order, etc.

That is how the detailed observation of this scene of a woman with the robot made it possible to specify the phenomenon of tactility.

In a first stage it was verified that tactility appears before any handling of the product. Tactility does not necessarily appear with touch: bodily understanding takes place in a virtual manner, as shown by G.H. Mead: "we see things in the dimensions and structure of the manipulatory area" [16]. That is how, by just looking at an object, our body knows the perceptual and particularly haptic encounter that will take place. This phenomenon of tactility was also seen in the design process, where the team members understand, and make themselves understood, in a perceptual register the representations of an object that does not yet exist by means of their gestures that simulate its use, or by means of linguistic expressions that call for a perceptive representation, but also using the available material artifacts, such as the meeting-room chairs, which were indispensable as perceptual references to conceive a public transport seat.

Then, in the handling of the culinary robot, a phenomenon was observed of the body that understands the resistance and materiality of the object and adjusts to it by finding tactics for its use. That is how, through tactile exploration, the product and its significance in use are made to emerge. At the level of the design process, it was seen in a similar way that the actors used existing products, dummies, prototypes, to explore and understand the materiality that the product they were designing should have and which allowed the same approach by "palpation" as that observed with the culinary robot. Thus, in the design process of the public transport seat, making a functional life-size dummy was decisive to adjust and materialize the concept of comfort that the future seat should have, beyond the biomechanical considerations. Each of the actors of the design, by

experimenting the dummy perceptually, could specify, within his own field of knowledge, and articulate with the others, the characteristics of the seat to generate the required comfort. It was also the experience of a collective body with this dummy that allowed the emergence of the final product.

These observations go to show a bodily intelligence that appears in relation to the objects, both in their use and in their design. This bodily intelligence has a specificity that phenomenologists have highlighted and that more contemporary authors [15, 19, 24] have reinterpreted from a socio-contextual standpoint. Therefore the bodies, through perception, understand reality within the immediate capture of its meaning. This capture of the sense takes place within a give social context that generates a specific behavior or "being-in-the-world", so the meaning of an object changes depending on its perception context.

In short, the concept of tactility defines the natural method by means of which the members of a community get to understand things for all practical purposes, supported by a natural shared knowledge: bodily understanding. This specific method does not necessarily involve "touching," because the perception of things even without touching them goes through a haptic interpretation, i.e., an interpretation in the bodily register. Tactility appears in the design processes as well as in the use processes of a product, and beyond the "intelligent" instruments that may be generated to design products adapted to the users; tactility operates invisibly as a common thread that relates the designers and users of a product.

5. Conclusion

Tactility was initially a proposal in response to the industrial problems that started this work, i.e., trying to find a model of "integration of the factors perceived in the conception of products." However, the author's role as a participating observer allowed not only to reveal tactility as a constitutive interaction phenomenon of industrial products, but it was presented as an alternative in the multidisciplinary model, and a multifocus that gave rise to the group of researchers in charge of this work. In this research a reflection similar to that expressed by Lloyd: "The main problem, however, is in deciding what real-world data to capture as, obviously, it is not possible to capture a real-world design process in its entirety." [14].

The proposed view, centered on reading a bodily intelligence that governs both a product's design and use processes, suggests a holistic (which takes into account the phenomena in their global and local expression), dynamic (that understands things "being done"), reflexive (that studies the role of the observer as a participant in the phenomena), and sensitive (that focuses on the involved bodily logics) viewpoints of the observed phenomena. Although the analyses presented here are derived from the empirical study of two types of projects, the hypothesis that the phenomenon of tactility exists in the whole design and use process of an industrial product is stated. This hypothesis is based on the universality of the perception processes that govern the design and use process, described extensively in a thesis that was carried out based on this study [1].

In spite of the above, and beyond the proposed approach that participates in a paradigmatic debate of the science of design, it is believed that the study, briefly presented in this article, can contribute to deepen the methodological reflection of design science by restating the pertinence of models of the hard sciences to systematize the viewpoints [14], and it is believed that the result obtained, which highlights a tacit phenomenon of design processes, can contribute to deepen the instrumental reflection in terms of product design, relocating the models of embodied design that are emerging within a bodily and not only conceptual space [23].

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