

# Designing a strategy to obtain technological solutions with co-creation and design thinking tools

Cubillos Rojas. Ángela Patricia

**Abstract**— The study of the technological design solutions is intended to enhance the technical micro design while remaining respectful of the people, including the social, cultural and environmental context-specific. This is a cross-sectional study, which with a Multi-method approach, which uses co-creation a central concept, using as data collection device like the participant observation, the use of interviews and the collaborative participation of the target population. On this research we included individual was involved in the technical basic tasks with and without technical tools, they was individuals with accumulated experience of one year in their work. The data logging process was carried out in three cycles of observation, work team video records and collection of on-worksite interviews.

As a result, we set the creation principles of working groups, their organizational strategies, techniques and some of the components of hard and soft character. The findings indicate the existence of mechanisms of self-regulation in the process of value creation, as well as the use of implicit knowledge directly linked to previous experiences, they which act as articulators of the activity techniques. In the same way is identified creation techniques based on the use of basic elements, low or medium complexity that facilitates the applied usage of the experiential knowledge developed individually and collectively.

**Index Terms**— Competencies, interaction, co-creation, design thinking, ergonomics.

## I. INTRODUCTION

The innovation is "a critical intersection between social systems" [1]. It is here where the work in cognitive anthropology set out the importance of analyzing the way how the solutions are constructed through technical exchanges [2]. It is clear that knowledge is transformed in the action and situation around the technical process. In the case of mining activities, is an activity that is developed collectively, it actions will have to ensure that the development of solutions considering the type of network operation which not only has a social content of support and endorsement, it is also at the level of specific techniques in order to obtain the best results. We highlights the importance of collaborative activities, there all can define the existence of a common goal for the ongoing activities and/or by the interdependence of the various operational activities involved in the pursuit of a goal [3], [4].

The types of collective activities are numerous and the terms used are polysemic [5]. In this study we use the typology of Rogalski [6]. Which applies to situations in which pre-exist collective tasks of the group of actors that need to perform and which are defined by the organization of work,

which corresponds to the organization of the collective intervention in the management of work activities. This typology has the horizontal dimensions, which relate to the actors at the same level, that is in the best interests will understand in the generation of the uses and therefore of the powers involved in these processes. In fact, the various forms of collective activities can be differentiated, presenting them from the more cooperative at least cooperative. In this sense, it is considered that the collaboration corresponds to situations in which a group of individuals accomplish a percentage of functioning of one task together, without defining the sub-tasks to be performed by each one.

Other dimension of this typology: is the co-action. Here, the operations do not have a common goal, but are present in the same space of work and possibly they share resources. The collective activity is defined as the minimum necessary for the management of the interference between the activities of the actors involved [7]. The term and the concept of co-creation, comes to understand the implications of the opposition between production and consumption, i.e. between the separation of those who decide what should be produced, including features, use and disposal whit the uses of these products; these co-creation users and actors could finally resort to modifications by setting goals and specifying new operational destinations of the products. Thanks to the developments of the systems of consumption and the ecosystems of innovation, there arises the need to not only refer to the recipient of the production on some specific aspects of the products, it is required they can that help define them, which open doors to the scene of the new technological solutions.

It is through the action chain comparison operation, that is to say are those that describe how the different groups perform technical actions of the same type where it is possible to identify the knowledge and technical know-how. This also gives place to identify more general representations with which each group and each culture execute actions in the physical world. In this sense, the co-creation suppose that individuals or groups of individuals and even communities create value in the technical solutions generate and this is generated independently of any established organization. The co-creation is a new and innovative approach, which involves the participation of various key actors for the design and development of a solution, the basis of the process of co-creation is the construction of means of interaction between the users and potential developers, designers or engineers that materialize of solutions, also it is necessary to take into account that these solutions can be generated in the contexts of activity or outside of their context.

The co-creation not only allows the participation of individuals or communities of individuals, also has an impact on the creation of value, and a great impact on the social, in

Cubillos R. Angela Patricia, Assoc. Prof. in Industrial Design Department, Engineering Faculty, Universidad Autónoma de Colombia, Bogotá, Colombia, Research fields are Technological challenges, Innovation, Ergonomics and Human Factors

effect the benefits of co-creation range from economic to social, which transcend the individual. The collaboration between the different participants not only increases the number of ideas, also paves the way for the generation of knowledge at the same time that makes it easier to share or distribute the knowledge gained by each author. The process allows access to collective and individual experiences, gives the opportune access for knowledge developed specifically to the contexts of action and enables you to document or describe specific skills developed by individuals in the interaction with the problems that usually in the context of activity. The processes of co-creation also enhance and facilitate the degrees of interaction between the blocks of actors, this becomes a great potential to recognize opportunities for developments, technological applications and uses specified by users. These applications dimensioned correctly can benefit the community object of study and in a longer-term reaches to society in general.

To approach the problem the adaptive capacity Sardan [8]. Speaks of the "innovators of bare feet", these researchers consider the innovation process, such as endogenous processes of nature, and invite you to take into consideration the contributions of the knowledge of the population in the social transformations and in the technical innovations. In the same vein Raulin [9]. Indicated the importance of these contributions to facilitate the dissemination of traditional techniques, as these are can contribute to solving the problems relating to the technical changes. In this same direction Creswell [10]. Pointed out that the selection of traditional techniques is linked to the analysis of the social relations, which fall within the technical organization of societies. The methodological stance derived from these postulates is to identify social groups and describe their activity in a context situation.

The work in cognitive anthropology [11]. Establishes the importance of analyzing the way that knowledge is built through technical exchanges. It is clear that knowledge is transformed in the action and in the situation around the technical problems. This conceptual framework explains the theoretical and conceptual integration of the research project on the strategy for co-creation. In effect the vision of the action as a transforming agent of knowledge, the design as a facilitator of the bridges between social actors and innovation as a change agent, come together to develop an approach created to find through these three concepts innovations that help solve the social problem of the mining and there serve as a model for addressing and resolving problems of similar technological complexity, taking into account the vulnerability of individuals that is inserted in this scenario of activity.

## II. MATERIAL AND METHODS

This study proposes as a hypothesis of departure "that the experiential knowledge derived from natural interactions

with others and with the context, this interactions are potential container of technological innovations". This implies that the "natural" interactions will be the object of analysis as independent variable, this makes it possible to explain the richness of the actions in situ; as dependent variables, the actions and uses was identified like the components of the content and meaning, these give rise to a model of co-creation oriented to the development of competencies for innovation. The strategy was developed through methodologies of co-creation and systematic observation of the activities. The empirical study of the wealth of the action was performed with groups of miners in fact that shared their portfolio of techniques, in order to establish analytically the complexity of the natural interactions and the ways in which the knowledge collaborate in the structuring of innovation competences.

From the methodological point of view, we designed the study for developing a strategy of co-creation oriented to find technological solutions; we perform all reviews and analyze the evidence related to the thinking design, considering the advantages and limitations of this for the model development. In this sense, the analysis was made of the framework of reference of concepts convergence of the creativity, the design and the science of creation, in the traditions of specific social groups in order to generate value in the use of technological solutions. This allows us to understand the technique creation as a social phenomenon in its own right in close relationship with other social phenomena. In order to identify the forms of action and the dynamics of activity in a real-life situation is developed a strategy of double registration that combined participant observation with interviews and analysis of contents from visual sequences. In order to identify the forms of action and the dynamics of activity in a real-life situation is developed a strategy of double registration that combined participant observation with interviews and analysis of contents from visual sequences

2.1 Population: The study was conducted with 30 workers, who used of technological tools or instruments, these workers were grouped in three sets according to the age and the activity and the selection was made for convenience.

2.2 Procedure: The methodological resource and the strategy of the study focused on explaining the phenomenon of the techniques used in their activities and what will be the condition for implement co-creation that will facilitate the development and implementation of innovations in this type of population. Consequently this is a study of non-experimental, cross-sectional nature, which seeks to establish causal relationships between the variables. The central axis of the hypothesis is: "the experiential knowledge result in natural interactions, that which are potential containers of innovations". This implies that the "natural" interactions will be the object of analysis as independent variable, whit this variable would be it possible to explain the richness of the action in situ, these actions are taken as

dependent variables. the actions and practices will be that enable us to identify the components of the content and meaning and these will give rise to a model of co-creation oriented to the innovation.

We must insist the empirical verification of the richness of the action depend in the first place on the formation of groups of workers that share its portfolio of techniques and allow access to the amplifying actions techniques, in order to establish analytically the complexity of the natural interactions. With this objective was carried out this study, the end of the same was to observe a small group of miners, in order to refine the processes of interview and verify the adequacy of the methodological strategy selected for the development of the research. This study was designed to develop on three sessions in a period of twelve months, we was included participants who regularly the work activity. The interviews were also developed in open field, in groups with physical spaces defined and with miners who practices their activity in a field defined by long periods of exploitation.

### III. RESULTS AND DISCUSSION

When we study a work activity we look for the structure of the cycle of the action from the observation of the actor in a given state (defined). This study integrates the physical and social environment, taking into account that the latter belongs to a certain culture (see figure 1). In this cycle of the action is what is meaningful for this actor is what is pre-reflexive of action, i.e. it is possible for any actor show, indicate, narrate and comment on every moment in the development of its activity to an observer or partner what he is doing [12]. Plus the integration of the cycle of experience (i.e. the Organization inherent on the cycle of action), could be integrated on the study to the actor and on the our relations that it maintains with the relevant particularities of their own activity; when activity that is observable, (extrinsic) calls on the situation in which it is plays. (This execution includes other actors who share it).

The activities of the workers observed are somehow regulated by the rules of loss that has defined the company that operated in the region, this led to the formation of groups of workers segmented for various reasons: firstly, the proximity and the support (counting with the endorsement), age (older workers may be at a disadvantage). In the second instance the group of workers who are looking for to conformed into cooperative units of exploitation, this are cohesive groups with a hierarchy of operation and that develop their activities according to their own rules of operation. These have intermediate techniques and follow a plan of search based on his experience and on the knowledge developed through practice. The third group is made up of workers who has an own work land, carried out a systematic search in a defined area, do not depend on external agents and self regulate your search. It is a practice based also in particular experiences and knowledge generally transferred by other workers.

The profile of the participants in this experience, indicates a strong expectation associated to chance, no processes that indicate a systematization of the search, nor is it to plan the activity, it is more of a task based on skills and focusing on a strong influence of the knowledge of the properties of the material or technological device with which it interacts. This also indicates to the individuals, the nature of the techniques

or of the means to be used, the process depends significantly on the capacity of individuals to recognize the function sought, and this is closely related to the senses and to the search for specific indicators that indicate the correct exploration path.

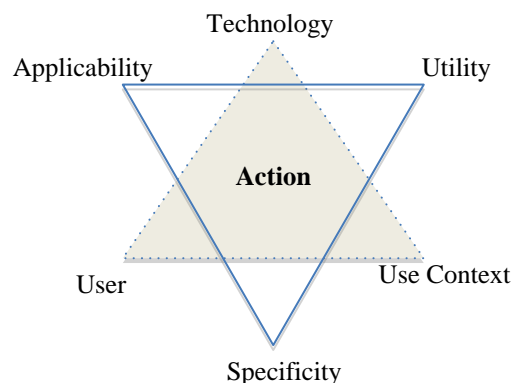


Figure (1): Structure of the action: Elements that interact in the development of the action. Source: Cubillos-R, AP. (2017)

It is important to consider that individuals do not explore functions by their purpose (Table 1); they, on the contrary, they guide their actions according to two principles: first, the specificity of what they are using, that is, they decipher effectively for which the solution was designed and according to this establishes what could be the possible applications of these; that is, they do not stop at the purpose established by the designer or engineer creator of the solution, they go further trying to find additional functions, which are judged by the convenience, adaptation or possibility offered by this technology to facilitate the use of prior knowledge or to reinforce solutions to insoluble situations.

The integration of the knowledge of individuals in the development of solutions not only must was of a material nature also is a social nature. The results of the analysis allows you to see that some of the solutions that would amend the search techniques of use and of exploitation of technologies are linked to organizational aspects and these are not only related to the individuals and groups. From the point of view of the knowledge you should know that an activity does not follow a regular cycle of execution, their actions which is heavily dependent on external conditions, the structure of the activity depends on both of one's own knowledge (to know how to locate in the context of exploitation), and those which are derived from the socially shared knowledge, these can be explicit (intra- group) or implied (Regulation inter group).

In the development of the activity no processes that indicate a systematization of the review, nor is it to plan the activity, it is more of a task based on skills and focusing on a strong influence of the knowledge of the properties of the technological object, the geographical context with which their interact, as well as other variables of emotional and many based on beliefs, in the same way is that the references plays an important role in the maintenance of the activity, which indicates on the individuals, the nature the techniques and of the means to be used, the process to find a new solution depends significantly on the capacity of individuals to recognize the sought, and this is closely related to the senses and to the search for specific indicators that indicate the correct search path.

Variable	Self-organized	Groups	Individual Workers
Conformation	Conforms in units of two and three individuals. With shared activities	Groups of more than five individuals with hierarchies and defined tasks	Groups of three, with defined roles and activities. With a horizontal organization
Rules of action	Determined by the outside, are defined on the basis of the external conditions of exploitation.	Defined collectively, but regulated by the coordinators	Defined on the basis of the experiences of the older.
Base of Technology	Basic elements, without complexity and with a strong tendency to re-use of industrial elements	Low complexity technology and uses of hand tools	Intermediate technology, with uses of stable systems and regulated
Cycles of action	Depend on access to the specific functions	Defined by the characteristics of the task, are regulated by the interest and motivation of the group	Defined by the characteristics of the task, are regulated by the interest and motivation of the leader or group
Limiting	The possibilities of findings future applications are strongly defined by the access to the functions on the devices and by the availability of the same	The experiential knowledge that allow them to recognize promising use ways	The experiential knowledge that allow them to recognize promising use ways

**Table I.** Type of groups in task execution and own natural interactions. Array of identifying typologies of groups for the development of the activity (Cubillos-R, A. 2017)

The innovation and the innovators must take into account that when these are communities "out of network", that is to say isolated communities of technology and from the advances of modern societies, in these communities generally the techniques and technologies that develop depend on specific skills, which have been either inherited or developed in collective process of refinement. It is precisely here, in this sequence adopted by the communities, where designers and engineers can find ways of solution does not envisaged by the designers, however they it must make them emerge through techniques that will help to bring out the knowledge that awarded the specificity to a technological solution.

On the other hand the design has historically been involved with the technology network, considering in general to individuals as recipients of its solutions and in which the processes of creation and development are given in the absence of these recipients. In this way and according to Wang, W et al. [13]. It is necessary to consider that "the process of design can be social, because it involves the people to think and design your own future, using their own ingenuity and resources available locally [14]. In practice, this type of co-creation requires that all those involved developing empathy, sharing and accepting equality in the process of Creation [15]. In addition, the effective participation is based on informed participation [16].

The co-creation is a participatory process that emphasizes on the social affinity, empathy and inclusion, which has as its purpose to collect the experiences endogenous to connect the

disadvantages technological, social and knowledge of communities. The processes of co-creation must be ordered to help communities to understand the value of your own knowledge", this should be a means so that they can be available to act; it is important to understand that this process is not to obtain a product, if not that its goal is to facilitate the participation and adhesion of individuals, that is to say the end it is the process itself. In groups of individuals with strong technical knowledge embedded in individual and collective experiences, the role of the designer expands and requires multiple skills to observe and engage in dialog with the participants, this process is not only to document, seeks to make an immersion into the culture of these groups to assist in the process of clarification of the knowledge that will be essential to a process of innovation.

Therefore, it emphasizes three key moments to develop with groups and communities of this type, this are to initiate the process of collective reflection on the nature of the work developed, then stimulates a joint follow-up to the principles expressed in such a way that they can changed and transferred to a solution that benefits and that it is possible to integrate all the members of the group participants. In the innovation that part of processes of co-creation, there is a need to integrate the action field and different work domains. The central axis is what people want as a solution or contribution to improve their own reality, in order to achieve this, it is necessary to obtain agreements on what is technically, economically, and socially feasible, considering at the same time the financial viability, i.e. it is a matter of balancing the three domains in a dimension of innovation.

### 3.1 ¿What is a natural interaction?

The natural interaction should be understood as a response that balances the skills, knowledge and experiences with the characteristics of the environment action; interaction is made up of gestures, actions and procedures adapted in terms of options and possibilities. Natural interaction transforms the activity of individuals, it is the experience embodied in action. Is the usual way to deal with the restrictions and requirements, contains cultural and social constructions, why was I could not explain only as a process. Outside of these elements, in the book "The Gesture and the Word", [17]. Leroi-Gourhan, enriched these prospects by implementing the concept of "operational chain", the author's define this like organized syntax actions involving gestures, tools, knowledge, leading to the transformation of a raw material into a manufactured product, thus natural interaction could be understood as "operational chain" socially and culturally structured.

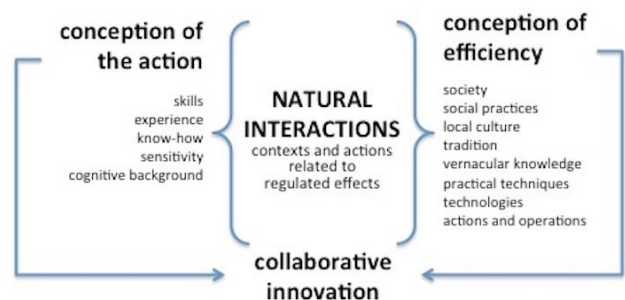


Figure (2): The diagram shows the set of elements linked and associated with the generation of natural interactions in productive activities. (Cubillos, A. Castillo. M. J-A. 2017).



From natural interactions perspective, the study of the forms of social regulation in creation process and the use of mediators, as well as the naturalization of the interaction techniques, should help identify the regularities and patterns in technical problem resolution, that are the origin of the efficiency and structure of innovation actions. The figure 2 shows some of the elements that must be identified, the best strategy is to make the process of co-creating like a conjugation of techniques derived of natural interaction, whit the purpose of collaboratively validate the structure of little additive actions oriented to innovation progressive, when the designer manage to set patterns, they can identify the key components of the operational chain, which they will be the key to innovation processes centered on technological developments.

The result of the integration of this model to study the problem of progressive innovation in real world, will be the development not only of social innovations in terms of means and ends, also the technological innovations what are good for society, they are so good and useful to improve the ability of individuals to act in technical way. The major innovation action; is the action, that will facilitate and optimize the capacity of action of individuals keeping unchanged the natural interactions. In this strategy of co-creation, allowing two-way flow of knowledge, those from individuals and their culture with those from the technical knowledge of the actors that facilitate the innovation process. We seeks to value knowledge, know-how and know-how developed under the tutelage of social practices.

#### IV. CONCLUSION

Since the beginning of the 21st century, it is was generating a growing relevance of the social components in innovation activities and development, specifically in the field of design has been established an interest in bringing together in the design social phenomena linked to the reality of communities and individuals [18], [19]. As they design can contribute to the development of the potential of each one of the individuals in society. The strategies of collaborative development of technological solutions that are based on the techniques used and stabilized through the practices of the actors, contribute to the design of solutions adapted to the needs of the social and economic ecosystems, this is of great importance, since this adaptation ensures its integration, as well as the inclusion of the practices and uses facilitates their implementation in order to obtain the value added in terms of the benefits of technological efficiency.

In this kind of scenario, the introduction of methods from the thought of design and the innovation with an approach on the use of co-creation process, introduce new elements of co-participation and co innovation, which are framed in the strategies of national and regional policies of open social innovation. It must be said that the co-creation is a form of integration of the knowledge of individuals in the development of solutions, as well as considering that these skills are not only of a material nature, also of a social nature. This study allowed to understand that some of the solutions that would amend the search techniques and exploitation are

linked to organizational aspects of the social groups, as these are not only relating to the individual and collective rights, it also involves the participation of communities and the national government, local and regional levels.

According to IDEO [20]. The activity of the social design is measured by the impact of their interventions, in this sense "the social impact is relative to the capacity of the interventions to create positive social change, which favor the change in the communities (for example, by improving the conditions and facilitating the development), is also measured by the social change in individuals (for example, by improving their social horizon for himself for his family nucleus). From this perspective the designers should recognize that the social reality is "different and independent of human beliefs and desires" [21]. This implies that in the social context, and in the complexities of the social fabric is not a single reality, there exist multiple realities, which are relative to the conditions where people develop their lives.

According to the international experiences when the process of co-creation is managed and is owned by local communities are often developed with greater ease and their innovation process are articulated in a dynamic way to the various companies, entities, foundations, thus creating networks of knowledge that remain in the time. One of the ways to achieve this is to think about the process of co-creation as a center of experimentation oriented to the innovation of the techniques, this means that their activities will be revalued the uses of the resources available, transforming them into technical solutions, probably technological to which they were attached to a contribution of innovation, this will impact not only to the individuals who participate in these projects, and also to those who act in a similar way the different places and also do so with minimal resources. Today, technological resources, the forms of collaboration between different actors and new scenarios that can be glimpsed in the daily activities of communities that derive their livelihood from activities that are running in precarious scenarios, provides an opportunity in imaginable for the engineering and design; the purpose of finding solutions from traditional practices by providing innovative knowledge fresh is a real alternative for innovation, absolutely necessary to connect the social realities with the technological expectation

#### REFERENCES

- [1] Long, N., Encounters at the interface: A perspective on social discontinuities in rural development. Wageningen Wageningen Studies in Sociology, 1989.
- [2] Hutchins, E., "Reasoning in Trobriand's discourse," in Casson, R. W. (ed.), Language, culture and cognition, New York, Mac Millan, pp. 481-489., 1981.
- [3] Barthe, B., & Quéinnec, Y. Terminologie et perspectives d'analyse du travail collectif en ergonomie. L'Année Psychologique, 99, 663-686. 1999.
- [4] Rogalski, J. Formation aux activités collectives. Le Travail humain, 57 (4), 367-386. 1994
- [5] Rogalski J. « La didactique professionnelle: une alternative aux approches de "cognition située" et "cognitiviste" en psychologie des acquisitions » @ctivités, 1 (2), 103-120. [en ligne] <http://www.activites.org/v1n2/Rogalski.pdf> . 2004.
- [6] Barthe, B., Quéinnec, Y., & Verdier, F. L'analyse de l'activité de travail en poste de nuit : bilan de 25 ans de recherches et perspectives. Le Travail Humain, 67(1) 41-61.

DOI : 10.3917/th.671.0041, 2004.

- [7] Hoc, J.M. Towards a cognitive approach to human-machine cooperation in dynamic situations. *International Journal of Human-Computer Studies*, 54, 509-540. 2001.
- [8] Sardan, J. P., *Anthropologie et développement*, APAD, Karthala, Paris. 1995.
- [9] Raulin, H., *La Dynamique des techniques agraires en Afrique du Nord*, Paris, Éditions du C.N.R.S. 1967.
- [10] Cresswell, R., "Transferts from techniques et chaînes opératoires", *Techniques et Culture*, n° 2, pp. 143-163. 1983.
- [11] Wisner, A., *Vers une anthropotechnologie*, Paris, CNAM (Laboratoire d'ergonomie). 1979.
- [12] Theureau, J. *Le cours d'action : Méthode développée*. Toulouse: Octarès Editions. 2006.
- [13] Wang, W., Ji, T., & Jaafarnia, M. Position designer into the craft revival of emerging markets: A case study on Chinese ethnic brocade industry. In *Proceedings of the 19th Conference on Design Management in an Era of Disruption* (pp. 187-204). London, UK: Design Management Institute. 2014.
- [14] Deacon, Terrence. *Incomplete Nature: How Mind Emerged from Matter*. New York: W.W. Norton & Co. 2012.
- [15] Fleischmann, K. Social entrepreneurs and social designers: Change makers with a new mindset? *International Journal of Business and Social Science*, 4(16), 9-17. 2013.
- [16] Woodhouse, E., & Patton, J. W. Design by society: Science and technology studies and the social shaping of design. *Design Issues*, 20(3), 1-12. 2004.
- [17] Leroi-gourhan, A. *Le geste et la parole II, La mémoire et les rythmes*, Paris, Albin Michel. [El gesto y la palabra, Caracas, Universidad central de Venezuela, 1972]. 1965.
- [18] Papanek, V. *Design for the Real World* (New York: Pantheon Books). 1971.
- [19] Bonsiepe, G. 'Precariousness and Ambiguity: Industrial Design in Dependent Countries' in *Design for Need* Bicknell, J. and McQiston, L. (eds.) pp. 13-19 (London: Pergamon Press, The RCA). 1973.
- [20] Ideo. *Design for Social Impact: How-to Guide*. The Rockefeller Foundation. 2010.
- [21] Miles, M.B. and Huberman, A.M. *An expanded sourcebook: Qualitative data analysis*. 2nd ed. London: Sage. 1994.

**Cubillos R. Angela Patricia**, Assoc. Prof. in Industrial Design Department, Engineering Faculty, Universidad Autónoma de Colombia, Bogotá, Colombia, Research fields are Technological challenges, Innovation, Ergonomics and Human Factors