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## **Collaborative design of interactive environments' behaviors**

Gabriela Carneiro, Gil Barros e Carlos Zibel

Gabriela Carneiro is Architect and Master in Theory and History of Architecture and Urbanism. She develops projects and gives courses and workshops that explore the digital technology appropriation on the design of objects and environments. Researcher at FAU-USP, where she deals with the design process of interactive buildings and spaces.

Gil Barros is Architect and Master in Electrical Engineering . Have experience in the areas of Interface Design, Information Architecture and Usability. Researcher at FAU-USP, where he proposes a sketching technique for interaction design.

Carlos Zibel is Architect, Designer, Artist and Doctor in Urban Environmental Structures. Associate Professor at FAU-USP at the Architecture, Urban Planning and Design courses. Senior researcher and vice scientific coordinator of the Center of Research in Architecture and Urbanism Technology (NUTAU) at *Universidade de São Paulo* (USP).

### **Abstract**

This article addresses some characteristics of the design process from interactive environments. Specifically, it analyzes a collaborative workshop whose results supplied inputs for the creation of an interactive environment projected for a digital producer central office. The innovative character of the space created the need for a differentiated process in which the clients and the company employees were key elements to provide information for the project. A card set named *i|o cards* was applied to ease the communication during the workshop. The cards represent the structural and conceptual elements we regard as essential for the design of this kind of space. The article presents the theoretical blueprints of the project, used methodology; it describes the workshop and analyzes the achieved results.

### **Introduction**

Numerous possibilities are opened up when environmental and building design incorporate computational system in their structure. According to the researchers Anna Vallgarda and Johan Redstrom (2007, p.513), "More recently, technological innovations such as smart materials and embedded computational resources have begun to influence design, in emerging

areas such as smart textiles and interactive architecture". Therefore, digital technology has been integrated to environment and buildings, in a way to accomplish the inclusion of dynamic and interactive aspects within space shape and perception. As a result, the digital programming of the ephemeral characteristics of the built environment, such as movement, sound and lights, also become an object of design.

Interactive architecture explores concepts related to the ubiquity and omnipresence of digital technology in the contemporary society. A resulting practice from a context in which "These two trends – the massive increase in computational power and the expanding context in which we put that power to use – both suggest that we need new ways of interacting with computers, ways that are better tuned to our need and abilities" (Dourish, 2004, p.02). This added to the cheapening of components and the development of simpler and more accessible programming syntaxes makes, day after day, architects and designers take possession of this language and explore the possibilities offered by digital media. Bill Moggridge (2007, p.639) adds to this statement when he says that "This all combines to indicate a way forward that connects the physical and digital, and offers us the chance to design interactions that are full of the richness of form and movement, freeing us from the feeling of being constrained by our computing devices".

This interdisciplinary field is still recent and full of possibilities, in a way that the most well-known form of application of the digital technology in space is still the one in which control and resources economy are the central issues. Michael Fox and Miles Kemp (2009, p.18), authors of the first book to outline interactive architecture as a specific actuation area, comment that, "Until recently (...) the notion of intelligence in the context of interactive environments revolved around a central control system for everything" and that "intelligent environments are defined as spaces in which computation is seamlessly used to enhance ordinary activity". However, for several architects and designers worried about exploring the impact of the digital media in the physical space, this impact goes much further.

In a recent interview, the media designer Joachim Sauter (2011), ART+COM's founder and director, describes the innovations brought by interactive spaces from two perspectives: the possibility of direct interaction with the space, and the addition of symbolic behavioral characteristics to the context. Regarding the first one, the dissemination of sensors and actuators in the space allows it to change its physical properties according people's usual behavior, that is, people can interfere in these characteristics even when they do not intend to, simply because they are present, talk to each other or move in space. The second perspective is about the designed behavior content, that is, the symbolic layers that can be added to space. Digital technology associated to the physical space allows several association possibilities, which makes possible the creation of open metaphors and real time interactions that makes us reflect about the contemporary world. Therefore, in the context of this article,

the term interactive architecture refers to the contemporary spaces that include these two characteristics: direct interaction and symbolic layer, implemented through digital technology.

In this context, conceiving a space whose characteristics include the possibility of interaction with the people who develop their daily activities there, still sets two important issues. The first one is the lack of references about interactive environment projects. For instance, when designing the physical space of an office there are several examples of studies made, it is all about flicking through a magazine or specific book on the subject. But this doesn't happen with the digital interactive aspects of the environment. The other issue is related to the collaborative initiative in the design process. Since one of the project's aspects regard its openness, the possibilities are very open and people still have difficulty to see what can be achieved. Given the lack of definition of this type of project, it was important to involve the final user alongside its development.

Having in mind this collaboration optimization, creative workshops become an important tool to extract from the clients and users information they would not be able to elaborate without the introduction of specific support. Therefore, when preparing a workshop, the designer imagines diverse possibilities to stimulate the participants to organize their ideas and, as a result, he's able to go beyond his own ideas and use these inputs to imagine other possibilities. Brian Lawson (2005, p.201) highlights this posture when he says, "Yet another way to challenge the direction of our thought is to interact directly with other people. Techniques such as brainstorming and synectics rely on the assumption that a group of people are not likely all to approach a problem in the same way, and that if the natural variety of the individuals can be harnessed the group may be more productive". Hence, a workshop can be thought to stimulate the discussion and the refine the design issues.

Elaborating a workshop means to set up a context to stimulate conversation and information exchange, in a directed way, among different groups. The groups, according to Lawson (2005, p.242), "act not just as a collection of individuals, but also in a manner somehow beyond the abilities of the collective individual talents". To optimize this process, besides the gathering of different participants, it is important to think about tools to stimulate the conversation among them, taking into consideration their different personal experience and professional background.

An interesting example of a tool used in creative sessions is the Method Cards (IDEO, 2002), developed by the IDEO office, a renowned American company that provides consultancy for the development of innovative products. They comprise a set of cards in which the main research methods used by the company are described. According to Bill Moggridge (2007, p.669)

The idea of the methods cards is to make a large number of different techniques accessible to all members of a design team and to encourage a creative approach to the search for information and insights as their

projects evolve. The intention is to provide a tool that can be used flexibly to sort, browse, search, spread out, or pin up.

Thus, this is an example that elucidates the kind of dynamic activity that can be achieved when cards are used as a discussion support in creative workshops.

In this way, by having a digital component, the design of interactive environments has a very particular aspect: the biggest part of its system's immateriality. Dan Saffer (2007, p.170), describes interactive objects and says that

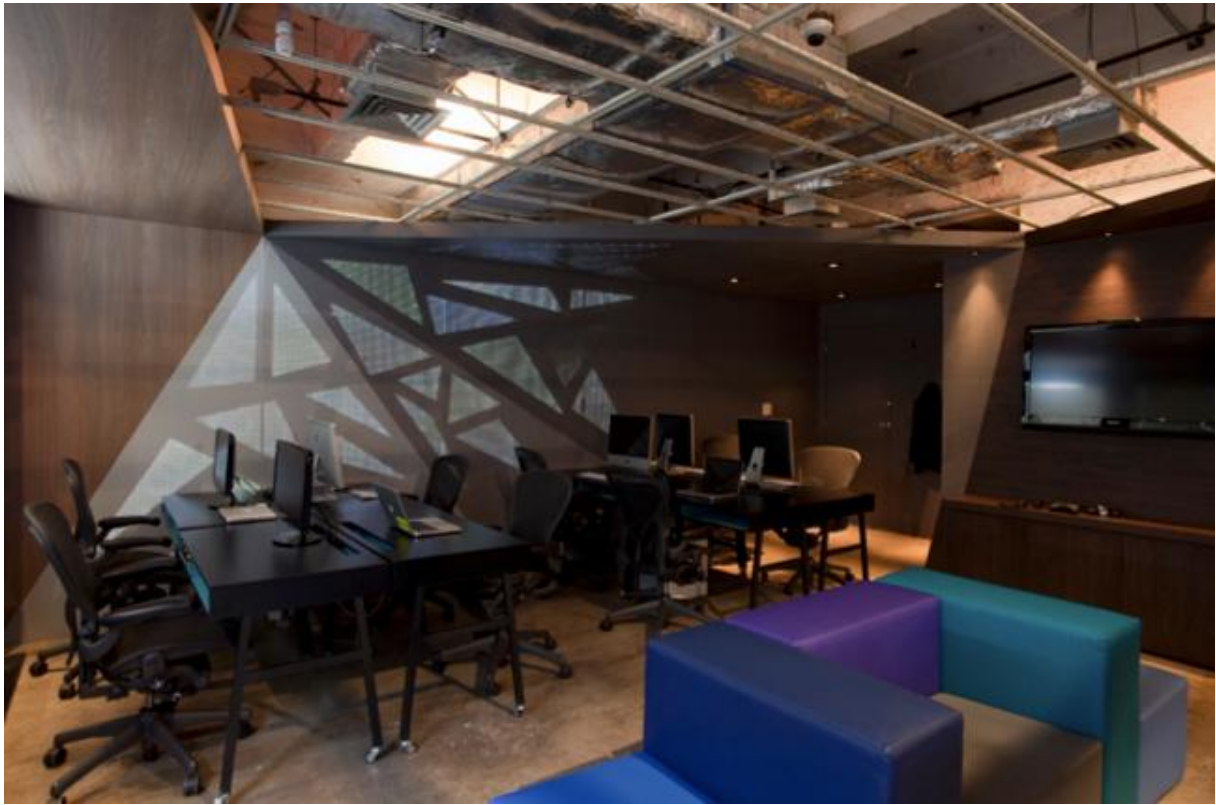
Digital products are a bit like icebergs. The part that can be seen (the interface) is really just the tip; what's below the surface, what isn't seen, is where the main part of the interaction design lies: the design decisions that the designer has made and the technical underpinnings that make the interface a reality.

As big part of these products' design is about its behavior and functionality, the development of tools that represent intangible elements of this system may serve as conversations support among different participants within a group activity.

Within the described context, it is suggested that the elaboration of workshops along with specific tools to make conversation easier during the activities, may turn out as an efficient way to design more meaningful interactive spaces. This hypothesis relates especially with projects that are focused in the dynamic and symbolic behaviors' development between people and space. From this point of view, this article presents the study of a collaborative dynamic case used in the development of an interactive environment project designed to be a company's main office.

### **Interactive Environment D3**

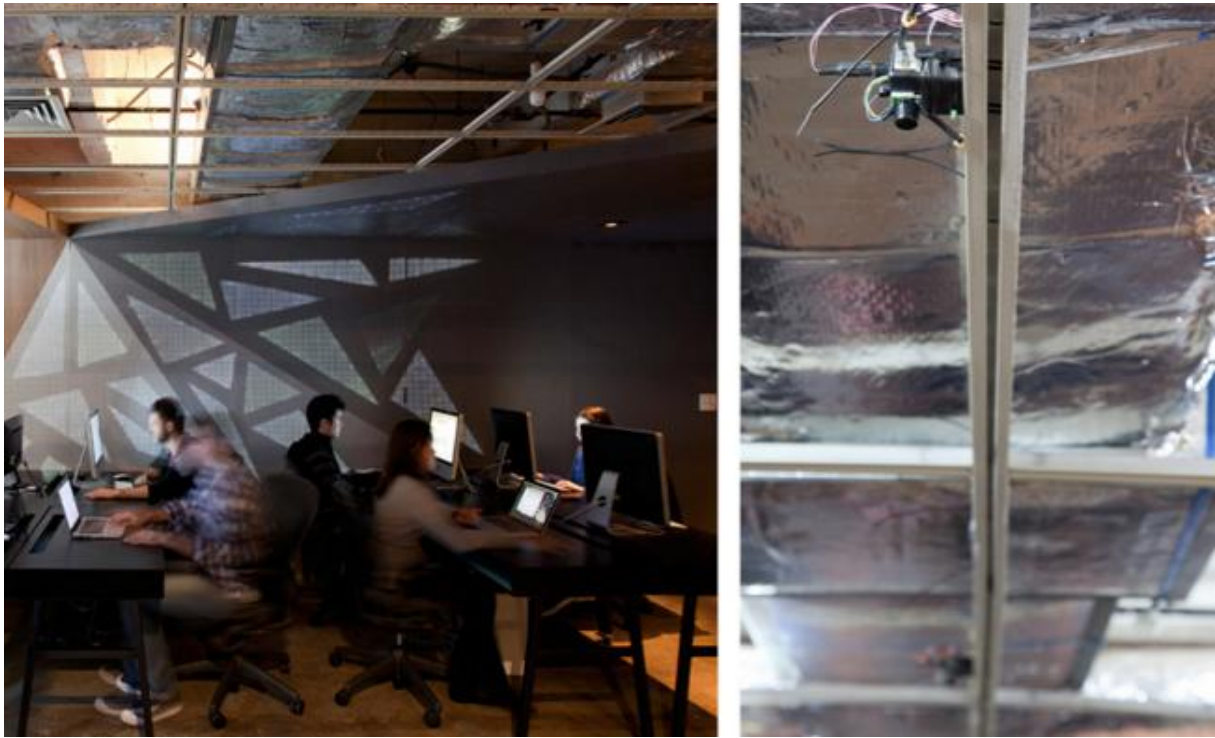
The interactive environment explored in this article was designed to be the head office of a digital producer, a company that works together with publicity agencies to produce apps and web sites (Figure 1). The fact that the company works with different media stimulated the conception of a space that reflects, as much as possible, the creative processes and activities that occurs there. That way, the introduction of an interactive layer and its system development was part of the design process, alongside with the choice of colors and materials that compose the space.



**Figure 1.** Picture of the final environment, result of the creation process described in this article (Photo: Fran Parente).

The project's purpose was to elaborate a holistic approximation in which digital media was present since the first sketches. In these sketches luminous patterns in one of the sidewalls were already been predicted, considering that it's design, based on irregular triangulations, followed the language adopted for the whole carpentry of the project. The patterns are composed of 25 luminous triangles, only visible when lit. Concerning space, it was opted to leave apparent the original space structure, making the hydraulics and electrical systems visible. In this structure were also connected the sensors that collect information about the activities which occur in the space (Figure 2).

This environment explores the two layers of interaction described by Sauter (2001). The same way people alter physical properties of space through their movement, they get to know a little bit more about the habits and activities which occur there. Besides, the project has a behavior that can be open and redesigned. In order to make this possible, an access for the whole system (luminous triangles, sensors) was provided on the Internet, making possible the users develop other interactive possibilities in the future.

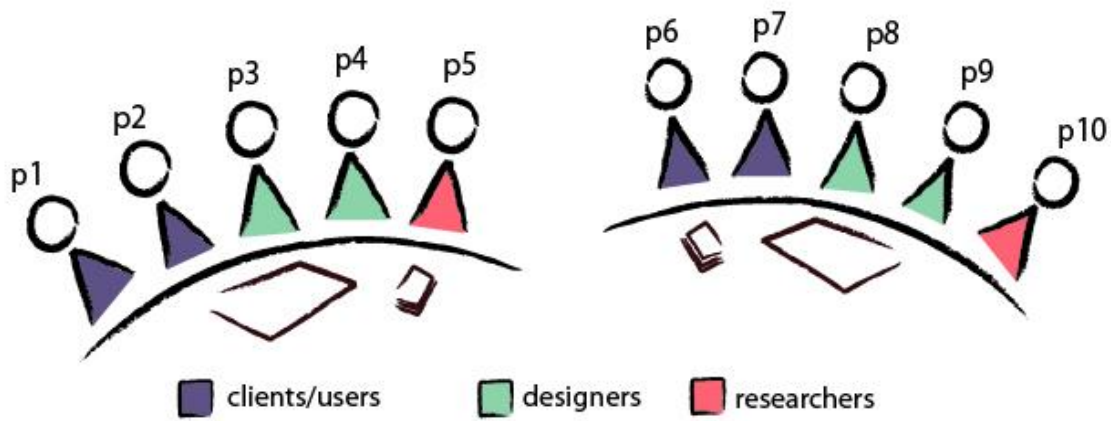


**Figure 2.** People working in space with the luminous panel working in the background (left) and detail of one of the ultrasonic sensors coupled to the apparent structure in the ceiling (right) (Photo: Fran Parente).

Since the beginning of this project, the intention was to achieve a horizontal creative process, with constant involvement and exchange among the different stakeholders. Therefore, besides the periodical meetings to evaluate the project pace, a specific creative workshop was elaborated for the project's conceptual finalization. The workshop goal was to raise relevant information about the company's activities and the clients and users' expectations and space appropriation. The workshop results were used to ground the sensor's choice, and the design of the behavior implemented in the environment.

## **The Workshop**

The workshop was a unique activity, controlled, that lasted one and a half hour, elaborated and mediated by one of the architects responsible for the project main concepts. It's role included the time management and to carry out the discussions, without the intention to directly intervene on the contents approached by the participants. Besides the mediator, the workshop was attended by two clients (users), two employees of the company (users), three architects, an electrical engineer and two invited researchers, totalizing 10 participants distributed in two groups, as presented in Figure 3. The groups were formed with the worry to balance the functions that the participants have in the project as a whole.



**Figure 3.** Distribution of the ten participants in the two groups set for the workshop.

With the triangle wall (output) already installed, the point of the discussion were the sensors which could be used to collect information (inputs) and the possible behaviors, that is, how the data affects the luminous triangle. Both groups debated on the space and the people's habits and behaviors, relating these ones with possible sensors and their interactions, which could happen in the environment. As support material, were adopted floor plans in scale 1:50 and the *i|o cards* (Carneiro, 2010), a set of cards developed to stimulate conversation and exchange of ideas during the design of interactive systems.

The *i|o cards* are divided in two groups: one deals with the interactive system's structural issues and the other one approaches some conceptual matters important for the creation of interactive experiences. The first group contains graphical representations of the microcontroller and of the main sensors-actuators that a beginner in the physical computing field usually gets to know, with the indication of the kind of information they supply (analogical or digital), as presented in Figure 4. The second group has in one of the surfaces, important concepts for the development on interactive behaviors focused on people's experiences, and in the other face brief explanations of these concepts (Figure 5). For this workshop, the conceptual group was adopted in its totality, while from the structural cards only the sensors were used, in such way that actuators and microcontroller were left aside.



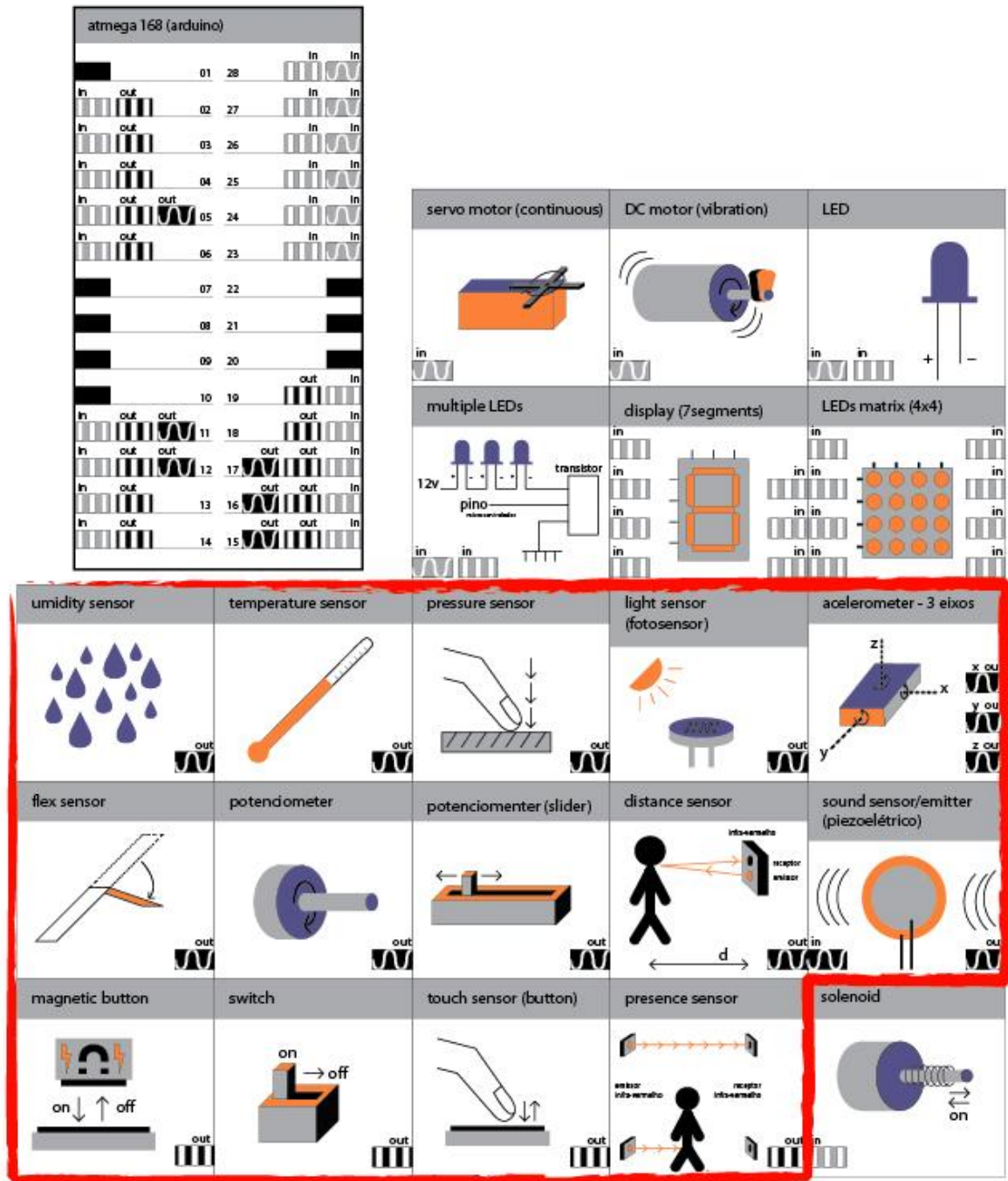


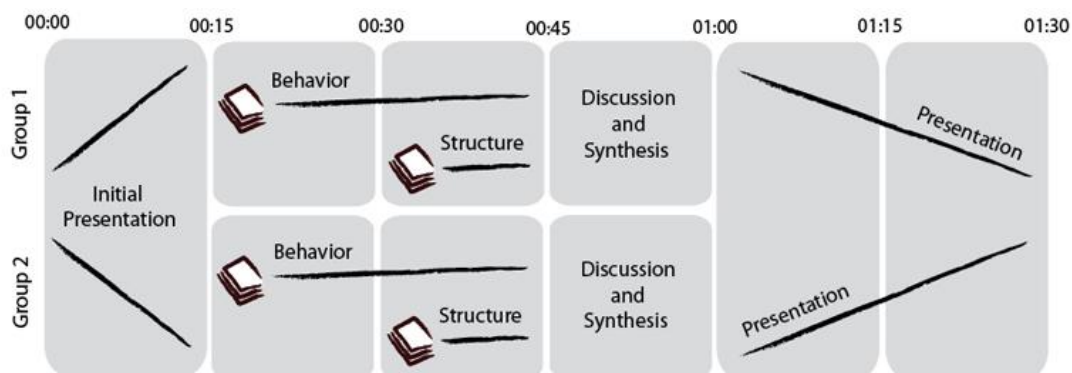
Figure 4. Structural cards of the i/o cards outlined in red are the cards used in this workshop (the sensors).



INVITATION	The first impression and signal the lets people know they can be involved. <i>How are people invited to participate?</i>	TIME	Interaction can happen over seconds, hours, days, years. The level of engagement should be appropriate to the length of time. <i>How do you keep momentum? How do you generate suspense?</i>
INCENTIVE	Knowing what will make people want to be involved and helping them envision what they can take out of the experience. <i>Whats the incentive?</i>	TECHNOLOGY	Interactivity does not necessitate the use of technology - it can lead to both exciting and distractions.
RULES	Whether implicit or explicit, flexible or rigid, rules let people know what's going on and how it works.	AUTHORSHIP	<i>How much of it will you share? How will you value other participants contribution?</i>
SENSES	Smelling, tasting feeling, pushing, pulling dancing - encouraging a greater connection and making the experience more personal and tangible. <i>What senses are you engaging?</i>	STRUCTURE	Open ended, open source - the framework determines when and how contribution should occur. <i>What is your structure for soliciting contributions?</i>
FEEDBACK	Letting people know that that what they've done has caused a relevant impact. Its role can be to reward, confirm or augment the participant's actions. <i>What feedback do people receive when they interact?</i>	UNEXPECTED	Where do we talk about the weather? Subversion? Anticipating those things which may suddenly appear and affect the project outcome ... or improve it!

**Figure 5.** Conceptual cards of the i|o cards.

Concerning the workshop dynamics, both groups started with the plans in hands. The cards were then distributed alternatively: **Group 1** started the activity with the structural elements (in this case, only sensors) and **Group 2** with the conceptual ones. After 15 minutes the rest of the cards were distributed for both groups. This way, one group was forced to begin the discussion by the technical issues and the other one by the experience. After 30 minutes of discussion, the groups had some time to organize the ideas and then present them, followed by a collective discussion. In Figure 6 we present the distribution of activities in time. At the end of the session, aiming to evaluate the activity, it was requested an e-mail from the participants with individual impressions about the workshop.



**Figure 6.** A distribution of the workshop activities during the period of one hour and a half. Detail for the alternate sequence of the distribution of the i|o cards between 00:15 and 00:45.

Regarding the adoption of the support material, there was a consensus between the two groups that it is more meaningful to start the discussion by the concepts before talking about technology. When reporting their ideas, Group 2, which received the structural cards first, made clear since the beginning that they would rather start the discussion by the concepts (what we want with space) then go to the technical part (how to carry out the chosen concepts). They reported that even with the sensors in hand, it was more natural to begin the discussion by the concepts and motivations. For this group, in the moment the concepts were delivered, they only checked if something was missing.

For Group 1, receiving the concepts already in the beginning helped them to manage the conversation (Picture 8). The words created an interesting scope for the discussion but were not used as a mandatory set of questions to be solved one by one. As a result, they specifically helped in special moments, such as when the rhythm of the conversation decreased. According to the participant 5's report "when the second group of cards appeared, the group handled it, talked a little about the sensors, but they did not stick to the subject for a long time and came back to the former discussion (...). The sensors came into discussion but, in my interpretation, subordinated to the initial point of the discussion" (our translation).



**Figure 7.** Group 1 discussing the concepts (left) and in the moment they received the structural cards (right). (Photo: Gabriela Carneiro)

Describing further the employment of the support material, it was observed that only Group 2 used the structural cards together with the space plans. Group 1 only looked at the cards and took notes on a paper without incorporating the space plans as support for the information. Besides the cards with content, Group 2 used some blank cards distributed to be freely adopted according to unexpected needs (Figure 8).



**Figure 8.** Group 2 organizing the plant cards (left) and plant ready for the final presentation (right). (Photo: Gabriela Carneiro)

In this case, Group 2 adopted the blank cards to represent sensors whose cards amount was not enough, as well as to include other types of sensors, besides the ones available in the *i|o cards*. In general the combination of space plan and cards demonstrated to be very useful to support the organization and final presentation of ideas.

## Results

As a result, the adopted workshop dynamic made possible a deep discussion of different possibilities for the environment in a relatively short time. The main ideas were synthesized by the participants themselves and presented in the final moment. To serve as input for the project, this presentation was recorded and then integrally transcribed. Next, the ideas were synthesized and used as inspiration for the design of the system behavior.

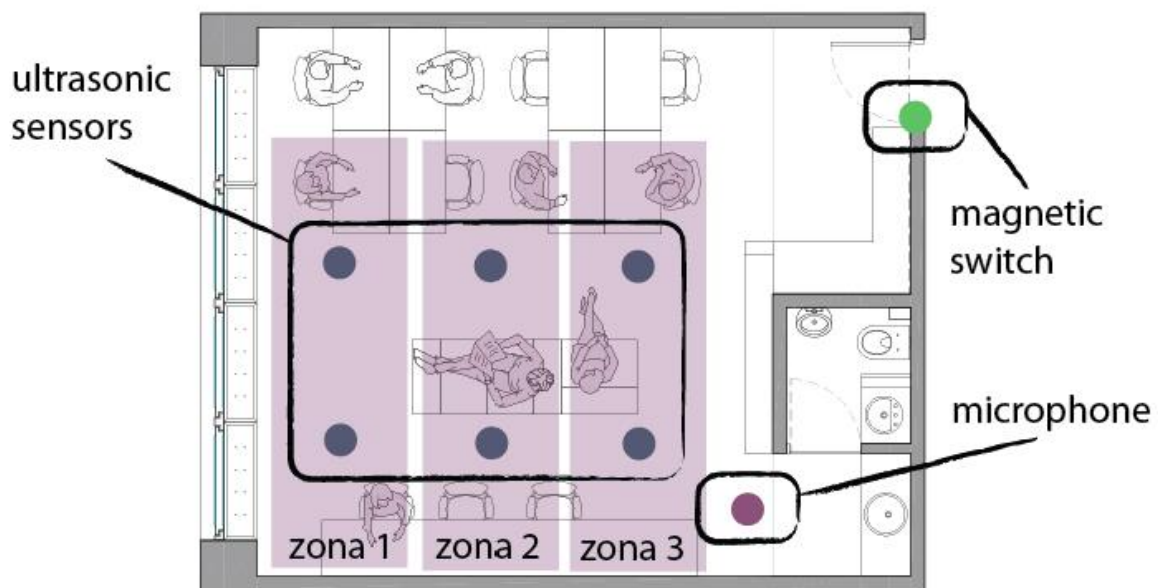
In Group 2 final presentation, the first one to comment its ideas, organized its talk on three types of interaction: events, behavior and control. Within the 'events', the group highlighted the importance of signaling people's arrival, in such a way that the visitors could realize quickly that something happened with the space with their presence. As an event, the group also mentioned the idea of games activated by the furniture. They categorized as 'behaviors' interactions such as the system's reaction according to the data network traffic or to the people's movement in space, as "footprints" of their actions. They emphasized the importance of these behaviors have a random component not to be boring. To complete it, the 'control' interaction comprehends the possibility of turning on, off and altering the luminous patterns.

Group 1 highlighted the issue of the interactions and time, how they relate to each other, including immediate reactions as well as long-termed behavioral changes. Besides that, from a close analysis of the company's employees, they mentioned the great variation between the

concentration moments, where everybody is sitting still, and the moments on which is clear a general enthusiasm. In the end, they also talked about the importance of thinking about the priority levels of the different behaviors.

## Behavior Design

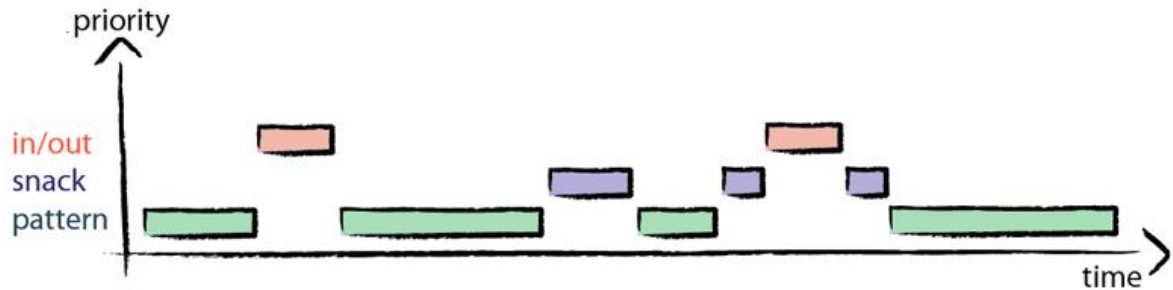
After reviewing the information gathered at the workshop, the sensors were set to be installed in space and its location, as well as the pattern behavior to be implemented. Besides the 25 luminous triangles the interactive system had also six ultrasonic sensors installed at the ceiling's structure, a microphone next to the kitchen and a sensor to capture the front door's opening and closing (Figure 9). The behavior was implemented in PHP language and can be altered and expanded by the own users and other developed behavior.



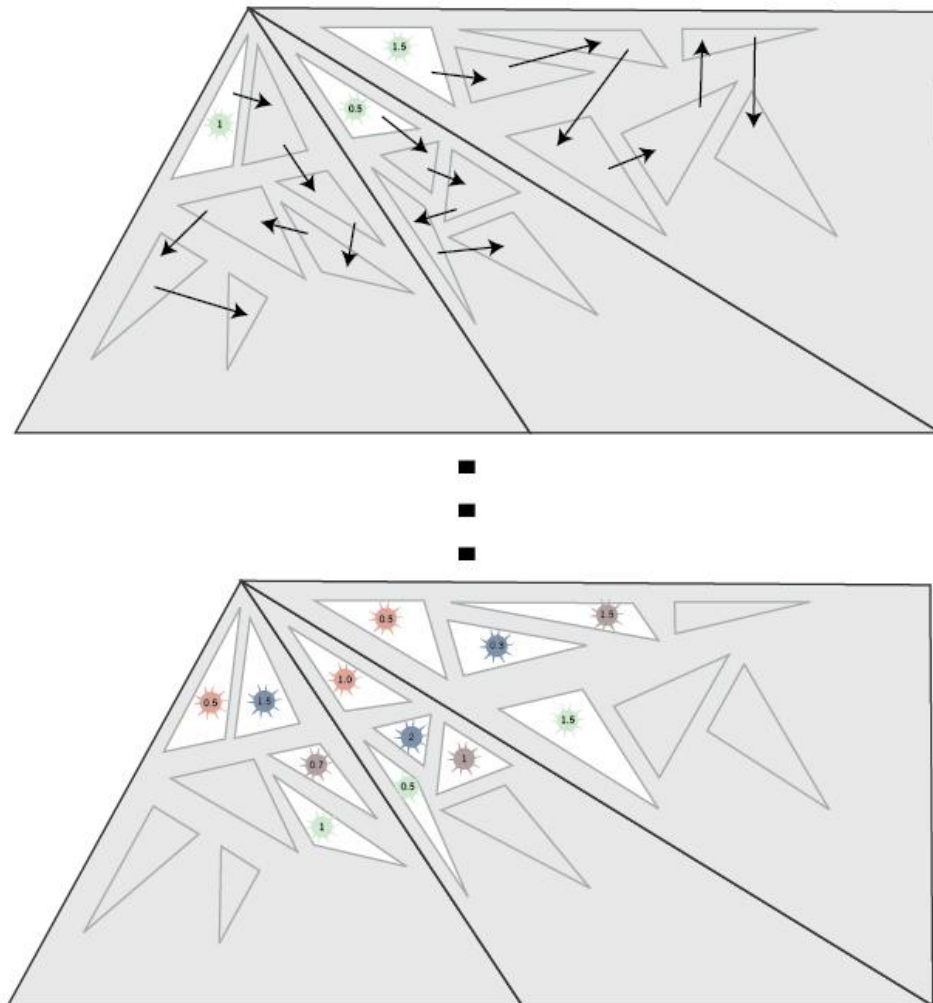
**Figure 9.** The choice and distribution of sensors in space was performed from the discussions at the workshop.

Three types of interaction were defined and distributed in time according to the level of importance. The most overriding interactions superposes over the others below, according to Figure 10. At the lowest level it's the standard interaction, that happens over the day and it's based on obtained values by the six ultrasonic distance sensors scattered in the apparent roof structure. For this interaction, the space and the luminous triangles were subdivided in three zones considering that the average of values the two present sensors in each zone determines the speed in which the first triangle of each group will blink. To every 10 seconds break, this value is reverberated to the next triangle and the first starts to blink from the sensors 'current

value. The goal is to, with time, each set of triangles reflect the occupation of the respective zone and that the set of all pattern reflect in an abstract way their moving of their occupants over time (Figure 11).



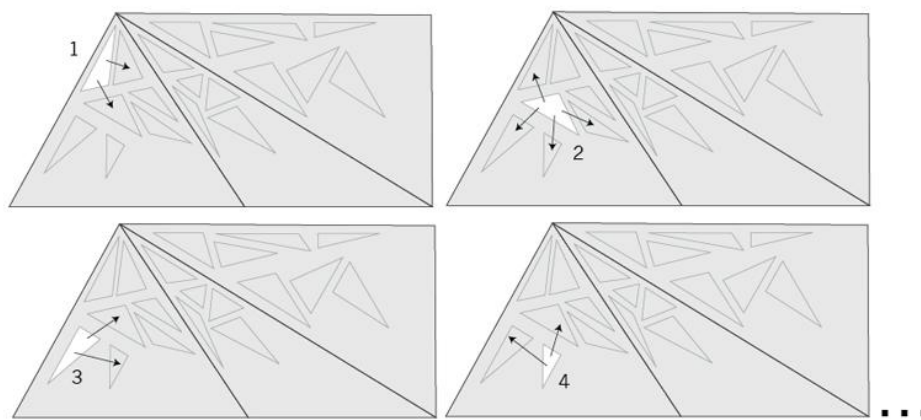
**Figure 10.** Graphic representation of the relation between interaction priority and their occurrence in time.



**Figure 11.** Standard interaction. The superior image shows the first step, which is, first triangle of each group blinks in different intensity (the star shows the blinking break in seconds). The image below shows the wall after four steps. The initial values will spread through the triangles of each group.

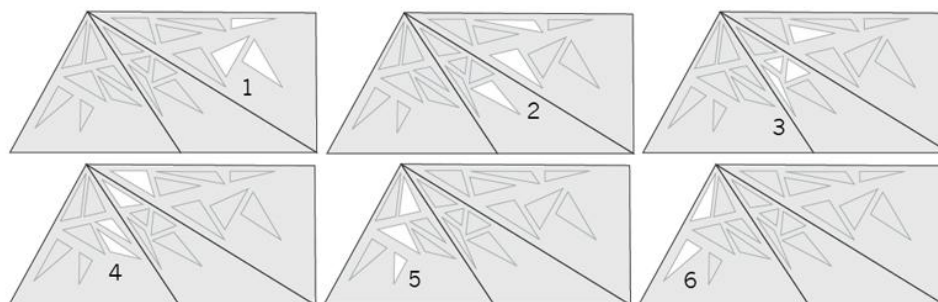


This standard interaction can be interrupted anytime by two others: the snack time or input and output of people in the space, and the last one having the last option maximum priority, in other words, comes before all the others when triggered. The snack time was pointed, during the workshop, as the main moment of conversation and relaxing of the company, so was decided to install a microphone in the canteen area. When the microphone receives a large precise stimulus, that is, when the value reaches a determined peak the interaction takes action. This is characterized by joking: only one triangle is lit and updates the value of the microphone which determines what will be the next one to be lit. Thus, other challenges can be created by people themselves, such as a contest of who can make light cross from one side to the other in less time (Figure 12).



**Figure 12.** Interaction of lunch. The first triangle is turned on and the next is determined by the value captured by the microphone.

The standard behavior of the third interaction is based on the will expressed during the workshop, to sign when important events happen, such as the arrival of visitors in space. For this reason, we installed a magnetic sensor that captures the opening / closing of the door. When triggered, a wave pattern is perpetuated in a movement of coming and going, which lasts up to five seconds after the door was closed again (Figure 13).



**Figure 13.** Interaction entry or exit of people. Once the door is opened, groups of triangles are set in a movement back and forth until the door is finally closed.



It was clear that the workshop contributed significantly to the project. The involvement of users assisted in the development of a behavior endowed with meaning for its users every day. Beyond the reach of the expected goal, several other points should be highlighted and discussed at the end of this article.

## **Conclusions**

The workshop included questions that go far beyond the inputs to create a standard behavior provided as part of the space in the initial proposal of the project. Among other findings it is important to emphasize its role of providing input for the definition of an effective behavior based on the use of space. In this sense, it is clear that inviting users to participate in the creative process does not mean that they will define questions, but they will generate data to be subsequently considered by the responsible designers. As Lawson (2005, p.90) points, is very important to understand the real demands of users of a system or environment.

For this project, the workshop also had a major role in the future of this environment. Once one of this interactive features of the system, developed for this space, is the possibility of future interventions through its reprogramming, the workshop generated inputs as for the users themselves. Specific ideas were not initially implemented may stimulate future interventions. It is important to highlight the development of interactive system, which foresees altering possibilities, was an elaborate answer given by the architects to the profile of clients and users, whose abilities include the programming of websites and notable opening for experimentations with digital technology. The architecture here goes beyond its role of involucres and the space itself acts as stimulator of creative activities and exchanges among its users.

The participation of clients and users in the design process through the workshop, also promoted the sense of ownership of space themselves. The participant 2 reports that "at the end, my own perception of the overall project has matured and now I'm more excited than before." Given the innovative nature of the proposal, assisted in the dynamic process of understanding and increased awareness and knowledge of people who will enjoy this spatiality, with regard to the opportunities present there's the possibility of future interventions through reprogramming, the workshop generated inputs for both architects and for their users. Specific ideas that were not initially implemented may encourage future interventions. Importantly, the development of an open interactive system - which provides the possibility of change - a response was drafted by the architects to the profile of customers and users, whose skills include programming websites and remarkable opening to experimenting with digital technology. Here the architecture goes beyond its role of dwelling and space itself acts as a stimulator of creative activities and exchanges among its users.

Another aspect to consider is the dynamic subsidy to expand the conceptual and practical repertoire of the participants in general. The mix of customers, users, architects and researchers provided a broad and mixed basis and clearly contributed to the enrichment of the discussions raised. According to participant 6, "I believe that all this has produced an incredible number of ideas and ideas to other ideas" (our translation).

The use of support material was an essential element for the successful outcome of the workshop. The letters and plants allowed the experimentation of the design of an interactive space, and opened the opportunity for questions and several other actions. It would also have been interesting to use media materials for the exploration of light patterns of the set of triangles. At one point, the second group came to sketch these standards in a paper, which states that thoughts about ways to facilitate and make it tangible also this support t would have further contributed to the final result (Figure 14).



**Figure 14.** Detail of the Group 2 and the triangulation of the sketches that made the wall to aid discussion.

The design for the head office for the digital producer is the result of a new generation of designers and customers who want an alternative way to work, characterized by experimentation, opening and collaboration of the processes. In this case, the process of development of the interactive system juxtaposed to the design of shapes, to the choice of colors and materials that make up the space, and transposes in it, the values cultivated by the people who dwell it. The result is the integration of physical and virtual instances on a single project in a way that goes beyond the functionalist discourse which is usually associated with technology.

In a world in which objects, cars, clothes and environments exchange information with people and detect their actions and activities, is necessary to think about how to expand and add new relations between men and their habitat. We believe that part of the responsibility of architects and designers to manipulate the technology to create objects and environments that inspire creativity and imagination in people's everyday lives.

## Thanks

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