Shaping the Absence
An Architectural Perspective for Interaction Design

Ambra Trotto*, **, Daniel Fallman*,***

** Interactive Institute Swedish ICT, ambra@tii.se*
*** Umeå School of Architecture, ambra.trotto@arch.umu.se*
**** Department of Informatics, Umeå University, dfallman@informatik.umu.se*

Abstract: Through the course *Dense Spaces 2012*—i.e. designing small, intelligent spaces such as elevators—carried out together with a group of architecture students at Umeå School of Architecture, Umeå University, Sweden, we report on, exemplify, and discuss how architectural theories, skills, and attitudes can come to complement and provide new food for thought for other design fields, including interaction design. We present the course, discuss some resulting spaces, and reflect on feedback from the participants. Then, we discuss some outcomes of the course that have broader implications. Unlike a more traditional technology-centered perspective, an architectural approach seems more prone to focus on designing what we term *dynamic absence*, i.e. design also concerned with what is not there. In a similar vein, an architectural approach also seems to address complexity by not fragmenting design challenges into smaller problems. The more holistic architectural attitude provides the opportunity to treat technology as a design material, along with the other architectural design materials the design situation offers, including structures, light, space, and absence. In this way, the architectural approach seems to shift the attention away from the design of representations and metaphors to instead focus on designing meaningful engagements in these spaces.

Keywords: Interaction design; architecture; dense spaces; space; absence; meaning; engagement.

1. Introduction

An increasing number of artificial spaces, including office buildings, hospitals, homes, public spaces, as well as more 'natural' spaces such as parks and recreation areas, are rapidly becoming augmented by a range of digital technologies such as sensors, actuators, and wireless communication technologies. In fields of research and design such as ubiquitous computing and pervasive computing, these environments are often addressed as 'smart' or 'intelligent', as they are combinations of physical structures and digital technologies set up to track, try to understand, and then respond in a clever way to human action.

While the combination of physical structures, digital technologies, and human actions in these environments obviously present an abundance of interesting issues for different kinds of technological research, ranging from developing new sensor hardware to artificial intelligence-like algorithms for tracking, understanding, and predicting human behavior, we argue that it may also be valuable to complement such technology-driven innovation and research with an architectural perspective. Hence, in a course entitled *Dense Spaces*, that we have carried out together with a group of architecture students at Umeå School of Architecture, Umeå University, Sweden, we report on, exemplify, and discuss how architectural theories, skills, and attitudes can come to

complement and enhance technology-driven approaches to the design of intelligent spaces and provide new food for thought for other design fields, including interaction design. Influences from traditional design disciplines, such as architecture—that in a historical sense has been much more important and influential than for instance industrial design, and which lately has had a strong impact on some more technology-centered fields of research such as Human-Computer Interaction—have not had a relevant role in developing the discipline of design for intelligent systems.

From a historical perspective, especially in northern Europe and the US, interaction design and industrial design, the "main hubs of constructive design research" [10], have been largely disjointed from research in the field of architecture. However, if we turn to some of the southern European countries, such as Italy, we find that the situation and history there is a bit different. Until the Bologna Declaration of 1999, education in industrial design has here been mostly nested into the education of architecture. The focus of these departments was, until only quite recently, on the 'traditional' branches of industrial design, where the integration of formal exploration and technological developments has been giving rise to incrementally innovative design outcomes, perfectly ready to feed industry (such as the automotive, furniture, or lighting industry), less able to neither envision nor materialize a radical paradigm shift. Also, in these countries, the role of design for intelligent systems as a discipline has been smaller than in northern Europe and the US. Because of this, architectural theories have been able to come in contact with and contaminate interaction design.

While it is possible to find a few promising examples of direct overlap between the fields of architecture and design for intelligent systems, including the research led at the Center for Interactive Spaces in Aahrus, Denmark [11] and the SENSEable City Lab at MIT, the collected body of literature in HCI that draws heavily and deeply on architectural theories, methods, and skills or which is entirely architecture-led is far from impressive [3] [7][12] [13] [14] [16]. Why is this and what are some of the new 'ways of seeing' that an architectural perspective can bring to design and research in the field of intelligent systems?

In this paper, we firstly present the thoughts that we had, that led us to further reflect on how these two disciplines currently relate and could relate; secondly, we use a design case of using architectural theory and skills in an interaction design project to discuss and exemplify some ways in which we think an architectural perspective on the design of interactions can complement, enhance, and provide new food for thought in the field of design for intelligent systems.

2. Architecture vs. design for intelligent systems

What are the common elements between architecture and design for intelligent systems? This is an important question that opens up an enormous discussion. It is definitely not our intention to attempt formulating a complete and comprehensive answer to this question. What we intend to do in the next three paragraphs, is just to present those thoughts that were inspiring for us; these are the topics that suggested us to further work on how these two disciplines relate, and how they can inform and enrich each other.

2.1 *Cultura del progetto*: the synthesis ability

The Florentine School of architecture and design has used the expression *"cultura del progetto"* (design culture), to define the attitude that is necessary, in all design disciplines, to design. Using the *adage* that Ernesto Nathan Rogers invented in the Athens Charter of 1953, (architectural) design deals with issues that span "from the

spoon to the city". As a matter of fact, the expression "design culture" condensates the ability of synthesizing a vision into a (palpable) (dynamic) form, thanks to a set of skills. This form is characterized by a function, by the aesthetics of its appearance and the aesthetics of the interaction that it elicits. This form is what will create opportunities for meaning to arise, when being used, determining the experience of use.

This ability of synthesizing a vision into a form integrates very different skills. These skills are mastered by designers, with the aim of creating a transformation, which emerges from the (integration of) designers' subjectivities, but also from social drives, personal experiences or the socio-cultural context that the designers belong [21]. These general statements on the disciplines are fully applicable both to design for intelligent system and to architectural design. In both, designers strive for merging the aesthetics of form and the aesthetics of interaction, on to a functional substrate.

If we leave the concept of 'intelligence' aside, we could dare state that architectural design is a class of design for systems, where lived environments are the focus of design itself. Architecture is concerned with what Lefebvre would name *the production of spaces*. Space, according to Lefebvre, is a social product, a complex construct, which grounds on the social production of meaning, which is based on values. Space affects perceptions, and as such, it influences, steers, sculpts social practices [8]. Meaning, although subjective, is collectively produced, during the intertwining of people's dynamics.

2.2 Intelligence and absence

The most apparent distinction between the two disciplinary fields is therefore constituted by 'intelligence'. If 'intelligence' boils down to having 'technology' in terms of sensors and actuators determining the behavior of the system, architecture is very often dumb. Architecture, until now, has been dealing mostly with solid materials. But there is a trend towards adaptivity of spaces, enabled through new materials, sensors, advanced lighting systems, embedded screens, which marks the overlap between the work of designers and architects. This requires, more than before, the ability to design dynamics environments. Domotics, Ubiquitous Computing, and Ambient Intelligence's related efforts, have tried to introduce embedded, context aware, personalized, adaptive and anticipatory technology into built environments [[1] [2], [22].

This introduction has arisen from a joint work between, what we here will call architects and designers[1]. What often happens in practice is that architects design the hard-core hardware of a building, i.e. floors, walls and ceilings, then designers face single rooms or a system of rooms (apartments or offices) to implement 'intelligence' in a discrete (in the sense of scattered) way. To avoid the Frankenstein effect, and in order to achieve harmonious results, where 'intelligence' is designed organically within the whole architectural concept, we might want to ignore practice and reflect on how intelligence and architecture could be treated together and how the relative theories can enrich each other. This requires shifting the focus of designing buildings to designing for spaces. Spaces are *absence*, the absence in which people can move about, perceive, experience and therefore conceive, between built materials. If we look at it from this perspective, the approach is very similar to designing for

[1] From now on, we will use the reductionist distinction between 'architects' and 'designers'. This distinction contrasts with the before mentioned communality between these species, which is exemplified by the ability of synthesising and materialising a vision, through 'design culture'. It is needed to do for reasons of clarity, to be able to make the point. In reality, this relation is obviously much more complex and the boundaries much more blurred.

interaction: also in this case, the interaction is the dynamic vacuum, existing between people's bodies (and related perceptive abilities) and the palpable part of products or systems. Meaning arises exactly in this vacuum, which is fluid and changes accordingly to people's moving about in the space. The absence reacts to people and in this absence, intrinsically meaningful experiences emanate. This is the fundamental similarity: if we want to design for meaning, we might consider to focus on designing the qualities of a dynamic absence in a space, no matter how intelligent this is.

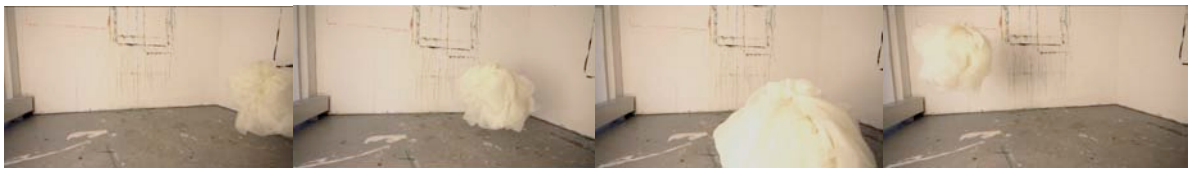

Figure 1 - In this example, a pre-existing space was redesigned, by introducing a swinging mass of tulle in it. The perceptual affordance of the space obviously mutated in a drastic way. The designers materialized dynamic qualities such as elegant suspension and constrained lightness. A video is to be found online [24].

2.3 The networked nature of social spaces

Another similarity between designing systems and designing architecture lies in the networked nature. There is a materiality that ends within the borders of the architectural assignment: the boundaries that have to be respected. Good architecture seamlessly integrates in its context, transforming flows, dynamics and habits of people. Spaces constitute a system, where there are one or more static physical knots (which are the buildings themselves) and various, dynamic knots, who are people. The link between the knots is the intentionality of people, and it is indeed a fluctuating, dynamic matter. The dynamic knots are like Heisenberg's particles: their position in space and time is not predictable. And not only the position of people, but their dynamic qualities, the emotional situation or the short or long term goals; none of it is precisely foreseeable. The practice of designing for categories of people does not work.

Lefebvre defines the concept of space in a way that is useful to mention here, since it is partly overlapping to the concept of systems, highlighting what is palpable and socially meaningful in how we want to design for them.

According to Lefebvre, space is a social concept. It is "not a thing among other things, nor a product among other products", it rather encompasses in a relational way all the things that are produced, and takes into account their "coexistence and simultaneity – their (relative) order and/or (relative) disorder". (Social) space, he argues, has nothing ideal or imagined. Space is in fact what elicits experience through the senses. He defines it as resulting from a sequence of operations (its production process) and it is what "permits fresh actions to occur, while suggesting others and prohibiting yet others" [8]. Would naming 'social space design' what we now call design for systems, be enough to generate a slight change of perspective, able to lead us to benefit of all the advantages of taking an architectural perspective to design? What are those benefits? Here we propose some reflections on possible pros, which emerged from a course given at the Umeå School of Architecture.

3. How can an architectural perspective enrich the practice of designing for intelligent systems?

From a reflection on the course process and results, we have observed three main elements that can inform the practice of designing for intelligent systems.

3.1 The exploration context

Below, we explain the context of the course. It took place in the spring of 2012 and was carried out with third-year students of the Bachelor Program at UMA, Laboratory of Architecture, Umeå, Sweden. In total, 42 students participated and completed the course, which lasted 4 weeks and was divided in 4 blocks: the first week was dedicated to sensitization towards designing qualities; the second focused on exploring designers perceptual motor skills and their meaning, to make them able to capitalize on their specificity and start a fruitful design dialogue with their colleagues within the design teams; the third week revolved around the design of spaces able to elicit human values; the fourth and last week was used to reflect on the results and the relations among the different experiences and the construction of the knowledge mass that could be dragged forward in their bachelor project.

3.2 Dense spaces

The course had the goal to train students of architecture in applying artistic theories and methods in a design process. The third-year students were already working on a macro-theme, in which they would further elaborate their final bachelor project. In order for them to tackle the macro-theme and work out a design concept to further develop, we wanted students to start making as soon as possible and then reflecting, in cycles of reflection-on-action. In designing the assignment and providing them with the tools to tackle it without getting lost in abstraction, it was necessary to find a way for them to make a physical, experienceable hypothesis of a space.

Designing implies creating opportunities for meaning to arise from a space. The space is relational and dynamic. By inserting constraints, one shapes these opportunities and elicits people's engagement with the space. The constraints that are created through the design, determine the quality of the space itself. That given, how to design for this quality? Frens states that "only through building (…) highly experiential prototypes can the quality of interaction be assessed" [6]. Scale is an evident issue, when designing architecture.

In the field of design for intelligent systems, working with experienceable prototyping as a generative tool for designing and assessing quality has shown to be a powerful approach, able to produce valuable results, both in terms of products and of design knowledge [10][15] [17]. When working in the field of architecture, one would need to build a space as an experiential prototype. This is rarely possible for obvious reasons. Not least, a massive demand of time and energy would not boost the concept generation. Is it then possible to make physical hypothesis of a space without actually building it? In the course at the Uma Laboratory of Architecture, this was done by working on "*Dense Spaces*". The *Dense Space* was a portion of a bigger space, which had to respond to certain requirements. The space had to share fundamental characteristics with the macro-theme they were working in. It should be able to condensate essential elements of the macro-theme: it could be both an internal or an external space; it could be wherever the designers wanted it, as long as easily reachable for them; designers had to be able to temporarily transform the space (for instance by adding material or juxtaposing constructions); the rough dimensions of the space had to be 300x300x300 cm; it could also be bigger, as long as they could control it all. The fact that other people could pass through it, or use the modified space, was a plus, useful for validation purposes.

For instance, one of the design team was working on the theme of interplay in architecture. Below, they describe their definition of Interplay in Architecture as well as their theme (the students were Albin Grind, Amanda Eliasson, Frida Stockhaus, Joanna Bark Jonsson, Joakim Svahn, Johannes Sverlander, and Lina Oldeen):

"The world we live in is made of a field of experiences and through the psycho-physical body we create with these our own subjective reality. This subjectivity is something we today feel is being questioned in the emergence of what one might call a new international style, a meta-architecture; the placeless architecture that is consumed through the rapid flow of architectural imagery that enforces the hegemony of the image over the experience. This is an architecture deprived of its essence. It is a limiting view on the potential of architecture as both an instrument of culture and a creator of experiences. This simplified approach needs to allow multiple and ambiguous readings of architecture in order to reach this potential. What is needed is to not see architecture as inanimate objects or merely containers of activity, but instead as the co-actor of our spatial consciousness and it is in the interplay with architecture we first truly experience or understand it. We believe architecture should be seen as an open field, defined by the interplay. In the interplay of man and architecture, architecture and society and society and man, infinite new realities are possible. Our research studio aims to investigate this interplay of architecture, society and man in order to find possibilities of new spaces and methods in which to act."

The team chose the elevator of the School's building as a *Dense Space*. It is an elevator that opens on opposite sites at the ground floor and only on one side at the other three floors. It is a dynamic space, within the static building and it is, by definition, a place in which the rules of usual interplay are scrambled, because of time and space constrictions.

Figure 2 - Left: image of the elevator, which portrays its mutational spatial nature. Right: image of a modification of the space of the elevator, to materialize qualities of lightness and playfulness with gravity. The space had been modified by inserting antennas, which would bounce during the movement of the elevator, anthropomorphizing it and enhancing the feeling of movement.

The design approach that they used, worked on iterations of reflections on action. According to the assignment, they first addressed how to design qualities, secondly how to boost their expressivity by means of using and reflecting on their skills and thirdly, how to design with/for values.

4. Designs and their richness: reflections

We now illustrate some examples of the outcomes of this course. The examples that we mention are only a small part among the final outcomes of the course above mentioned. After having run the course and while reviewing the material that was produced during the course, some of the outcomes were of inspiration to

formulate reflections that can contribute to our exploration on how an architectural perspective can enrich design for intelligent systems.

The results of the course are still concepts, not final products. Yet, they cannot be considered purely as artistic explorations, but rather as products of research through design, and, as such, material for informing and inspiring further design processes.

4.1 Enough with Devices

A team of students, occupied with the second assignment of the course, designed a space able to merge the expressivities of each team member. Based on a method developed by Trotto and Hummels [20], the way to evaluate and reflect on the team member's expressivity was based on previous exercises, aimed at defining salient elements of one of their (perceptual-motor) skills. The team members worked on diverse skills such as down-hill skiing, barista coffee connoisseurship, cart-wheeling, and sword dancing. They explored the dynamic subtleties of their own skills and compared them to those of their teammates. They investigated how these elements assumed different connotations and intensities in each of their skills. The main elements that appeared to be in common were balance and control and their mutual balance.

They used their reflection on this balance as a focal ingredient of the redesign of their *Dense Space*. The space that the students chose to work with, which was in line with their macro-theme of urban renovation, was an atelier space in the old Umeå Art Academy, waiting to be renovated. They designed a room in the existing atelier room. This room was mobile and built out of thick semi-translucent nylon, held together by a horizontal square wooden frame. It would rise, thanks to a system of pulleys, only when a stick hanging in the middle of the space was pulled down. The person pulling down the stick found himself in the middle, far enough from the 'walls' not to be able to touch them. The room had to be actively kept there, it required engagement and provided intimacy. When the stick was released, the room folded down and collapsed on the floor again (See Figure 3). The concept of a space that requires a massive physical engagement to be perceived and even to exist is fascinating: if engagement is required, the final result is not a device, but a *focal thing*, to use Borgmann's definition. The video of the space is visible online [23].

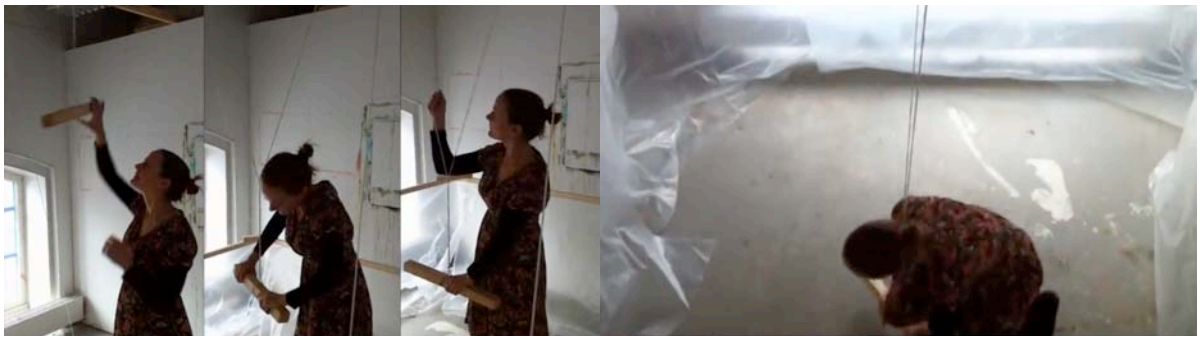

Figure 3 – In order to be in the room, one has to "build" it, by pushing on the floor a hanging stick. The movement requires a total engagement of the body and an active status. The space that arises is an intimate space, which filters the perception of the surroundings with its semi-translucent membrane and absence of openings. As soon as the stick is released, the room collapses.

This example suggests that one of the potentialities of the architectural perspective is to shift the pivot of attention, when designing, so that we might avoid the temptation of designing what philosopher of technology Albert Borgmann addresses as '*devices'* [[4], [5], [9]. Besides being mass-produced artifacts, Borgmann describes

devices as characterized by disposability, providing discontinuity with their larger context, and separating mean and ends. In opposition to what he calls focal things, devices tend to "contribute to a life that lacks a centre and that is missing a rich social and ecological context" [9]. One might reflect upon and question the over-abundance of devices in our present world. The sliding of devices into gizmos, impose a questioning of their necessity in a world where resources are becoming more and more precious, and therefore issues as the environment and economical impact of production processes, raw materials or distribution efforts have to be taken into account by designers.

A spatial perspective, we believe, contributes to maintaining a strong connection with the 'real' world (versus an imagined world). This helps not to design representations of reality. Representations, in fact, simplify reality and underestimate its complexity. A spatial perspective can support in designing for embodiment, instead of representations.

4.2 The three-dimensional attitude

The example that we are about to describe was a result of the group working on the theme of interplay and that chose the elevator as a *Dense Space,* as previously illustrated. While working on the third assignment of the course, which aimed at designing for human values, the team elaborated on the right of citizens to freely participate to the cultural life of the community. They explored how daily actions can end up in interesting cultural outcomes and asked themselves how it is possible create a space where anybody using the elevator can choose to interact in an on-going game with words. They designed a wooden structure, composed of two lateral pillars and a connecting surface. The pillars would host a vertical pile of 30x30mm cubes. The connecting surface was made to contain a row of seven of them. Each face of each cube had a word written on it. The horizontal row of cubes was accessible only when the door of the elevator was closed.

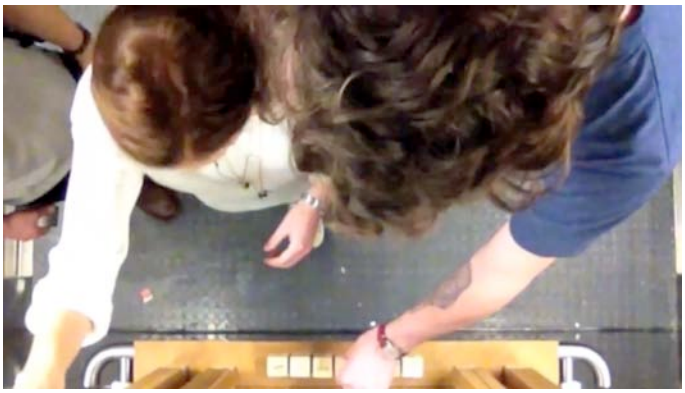

Figure 4 – Rules of proximity are scrambled thanks to the change of time and space and to the bodily involvement that the activity requires [26].

As soon as the door opened, a case covered the row, impeding to play with the cubes. During the trip in the elevator, people could compose offhand "poetry", playing with word and leaving messages behind. Since the school elevator serves only four storeys, the trips were very fast, only few seconds. This completely changed the perception of the space, scrambling both categories of space and time in a familiar, but often disliked space, such as the elevator.

The requirement of bodily involvement and the physical connection of the message platform to the space, make of the outcome and interesting example of what we called the three-dimensional attitude.

Another reflection that emerged with the help of this example is that a spatial perspective to design implies a 'three-dimensional attitude'. This tendency, which is possible to train, influences the way a space or a system come to inform. It might shift the attention from designing 'visualizations' on visual supports (screens) to designing 'action possibilities' and therefore meaningful engagements in spaces. The power of visualization, but also its deceitfulness, are recognized and broadly used in our era. Lefebvre provokingly claims that "sight and seeing, which in the Western tradition once epitomized intelligibility, have turned into a trap: the means whereby in a social space, diversity may be simulated and a travesty of enlightenment and intelligibility ensconced under the sign of transparency". This position, which might appear extreme, elicits an equally daring reflection concerning the honesty of interaction. Interaction, where meaning emanates, is transparent, it is not visible, it does not appeal the over stimulated sense of sight. From interaction, meaning emanates, and since it is subjective, because it addresses the senses and the dynamic body, it can only be sincere.

4.3 Technology as a material

The same team that chose the elevator as a Dense Space, worked on the first assignment, which required translating the dynamic qualities of a dance into the Dense Space. The dance clip they were assigned portrayed a dancer stepping on a series of chairs, aligned on a grass field, one after the other. She started running on the grass towards the first chair, stepped on its seat and right after climbed on the edge of the backrest, and fell gently on the grass, together with the chair, where she continued running towards the following chair. While doing this, she emitted a sound, modulating the pitch according to the height she was reaching, reinforcing the sinusoidal movement of her run. The students analyzed the dance and decided to look for a way to reinforce the vertical dynamics of the elevator. They achieved their purpose, by enhancing the expression of the elevator's movement: they placed on one side of the elevator's floor, several metal rods, about 6 mm diameter and a meter long. These sorts of 'antennas' reinforced the feeling of movement and acceleration, which in an elevator is only slightly perceivable [25].

The experience of the elevator is completely altered, with a very low-tech insertion. It is easy to imagine that, in a traditional design environment, the perceptual enhancement of the elevator's acceleration could have easily be solved with digital visualization or systems of sensors and actuators. Part of the charm of this design proposal is its simplicity though. A special perspective has probably contributed to achieve it.

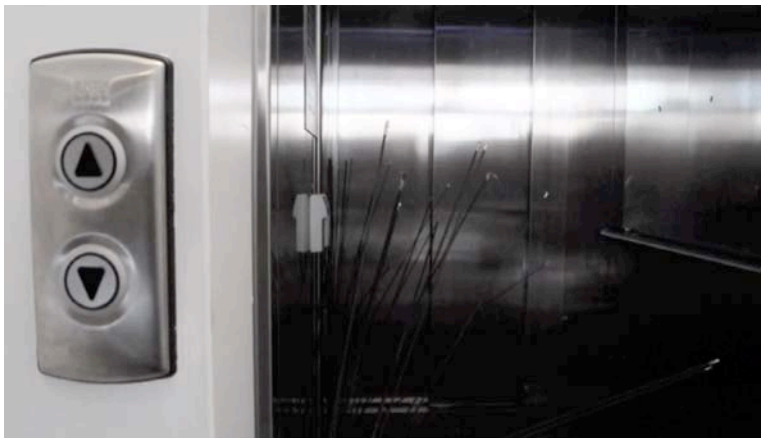

Figure 5 – The dynamics of the elevator is enhanced, by inserting 'antennas' in it. The low-tech solution offers a very attractive new flair of the elevator's space [25].

Yet another reflection arose from the course: the architectural perspective, in combination with the use of experienceable prototypes and videos, can support in envisioning interactive qualities of spaces, without falling into the temptation of abusing 'technology'. This possibly empowers towards the opportunity of treating 'technology' (electronics in terms of sensors and actuators) as a design material. In our experience in education, it happens that, when working in the domain of intelligent products and systems design, students often tend to design applications for new technologies. They cannot resist adding electronic components and 'intelligent' features, without first taking into account the possibility of low-tech solutions, which might be as effective.

5. Conclusions

Based on a number of design explorations in *Dense Spaces*, i.e. small, intelligent spaces such as elevators, carried out together with a group of architecture students at Umea School of Architecture, Umea University, Sweden, we have discussed how and why we believe architectural theories, skills, and attitudes can come to complement, enhance, and provide new food for thought for other design fields as well, such as interaction design.

In total, 42 students participated in the 4-week-long course which was divided in 4 blocks: the first week was dedicated to design qualities; the second focused on exploring perceptual motor skills and their meaning; the third week revolved around the design of spaces able to elicit human values; while the last week was used to reflect on the results and the relations among the different experiences. The course had the overarching goal to train students of architecture in relating to and applying artistic theories and methods in actual design processes. During the course, the participating students were also asked to find and elaborate on individual macro-themes, i.e. topics that they could further develop as for instance their final bachelor projects. The process of making was a central theme and we wanted the students make and then reflect on their action, both in terms of the tangible outcomes but also on their processes.

We have presented the course itself, discussed some of the resulting spaces, and reflected on feedback from the course participants. We have also analyzed and discussed some outcomes of the course that we think have broader implications.

The first aspect that emerged is that approaching the design of interaction from an architectural perspective helps in holistically focusing on designing the dynamic absence between 'walls' and the flow of people. It therefore helps in designing the 'choreography of interaction' and materializing it through limitations of dynamics in the *vacuum*, i.e. the empty space. This leads to a second consideration: since the focus is on the space and not on objects, this temptation of designing devices can be eluded. In this way, the architectural approach seems to, first, shift the pivot of attention away from the role of *devices* to *things*, using Borgmann's terms [4], and second, in doing so also come to shift the attention away from the design of visualizations, representations, and metaphors to instead focus on designing 'action possibilities', i.e. meaningful engagements in these spaces.

Besides, it seems to be easier to concentrate on meaning, because a spatial approach shifts the focus on designing the dynamic engagement of people in an environment or their action possibilities. This approach tends, for instance, to use technologies not as conceptual or executional drivers in designing, but rather as materials.

These aspects can be further abstracted into a more fundamental element: approaching the design of interaction from an architectural perspective concurs in taking a spatial perspective, which addresses people in a more organic and holistic way. It contributes in 'respectfully' addressing complexity, avoiding positivistic drives of splintering

the design challenge in smaller ‘problems’, where a ‘solution’ has to be found, and the envisioning effort has been left aside. An architectural approach seems to help in holistically focusing on designing what we call ‘dynamic absence’, i.e., also what is not *there* in terms of technology. This provides the opportunity to treat technology as a design material, along with the other architectural design materials the design situation offers, including structures, light, space, and absence.

6. Acknowledgements

We would like to thank all the students of UMA Laboratory of architecture, who were involved in the project, for their enthusiasm, skills and inspiration to support us in the exploration of meaningfulness in design.

7. References

[1]. Aarts, E., Marzano, S. (Eds.) (2003). *The New Everyday: Visions of Ambient Intelligence*. 010 Publishers.

[2]. Bell, G. and Dourish, P. (2007). *Yesterday's Tomorrows: Notes on Ubiquitous Computing's Dominant Vision. Personal and Ubiquitous Computing*, 11(2), pp.133-143.

[3]. Bratton, B. *What Do We Mean by 'Program?'*: The Convergence of Architecture and Interface Design" (May + June, 2008).

[4]. Borgmann, A. (1984). *Technology and the Character of Contemporary Life,* Univ. of Chicago Press.

[5]. Fallman, D. (2010) *A Different Way of Seeing: Albert Borgmann's Philosophy of Technology and Human-Computer Interaction*. AI & Society*,* 25.1, pp. 53-60.

[6]. Frens, J.W. (2006). *Rich Interaction. Integrating Form, Interaction and Function*. Doctoral dissertation, Eindhoven University of Technology.

[7]. Gross, M. D. and Green, K. E. (2012). *Architectural Robotics, Inevitably*, (January + February, 2012).

[8]. Lefebvre, H. (1974). *La production de l’espace*. Anthropos, Paris, 2000.

[9]. Higgs, E., Light, A., Strong, D. (2000). *Technology and the Good Life?* Chicago University Press.

[10]. Koskinen I. et al. (2011). *Design Research through Practice*. Morgan Kaufman.

[11]. Krogh, P. G., Fogtman, M. H., Markussen, T. (2011). *Designing Computational Artefacts as Architecture*. In proceedings for DPPI 2011, ACM, Milano.

[12]. Mitchell, W. (1999). *E-topia,* Boston, MIT Press.

[13]. McCullough, M. (2005). *Digital Ground.* Boston, MIT Press.

[14]. Negroponte, N. (1975). *Soft Architecture Machines*. Boston, MIT Press.

[15]. Overbeeke, C.J., Wensveen, S.A.G. and Hummels, C.C.M. (2006). *Design research: Generating Knowledge through Doing. Drawing New Territories*. 3rd Symposium of Design Research, Swiss Design Network, Nov. 17-18, 2006, pp. 51-69.

[16]. Pask, G. (1969). *The Architectural Relevance of Cybernetics*. AD September 1969.

[17]. Stappers, P.J. (2011). Workshop *JumpStart in Research* in Delft, June 29, 2010. An updated list will reappear in 2011 in the PROTO:type 2010 Symposoim held in Dundee, Scotland.

[18]. Superstudio, (1967). *Invention Design and Evasion Design*. In Ockman, J. (Ed.) Architecture Culture 1943-1968: A Documentary Anthology (New York, Columbia Books of Architecture / Rizzoli 1993)

[19]. Till, J. (2009) Architecture depends. MIT Press.

[20]. Trotto, A., Hummels, C.C.M., Cruz Restrepo M. (2011). *Towards design-driven innovation: designing for points of view using intuition through skills*. In Proceedings of Designing Pleasurable Products and Interfaces, June 22– 25, 2011, Milan, Italy, pp. 3-9.

[21]. Trotto, A. (2011) *Rights through Making. Skills for pervasive ethics*. Doctoral dissertation, Eindhoven University of Technology.

[22]. Weiser, M. (1991). *The computer for the 21st Century*. Sci Am 265(3), pp.94–104

[23]. http://uma3thefutureofthepast.wordpress.com/week-2-2/video-d/

[24]. https://vimeo.com/40996215

[25]. http://uma3studio6.wordpress.com/2012/03/02/sensitive-dialogue/

[26]. http://uma3studio6.wordpress.com/2012/03/16/values-video-e-2/