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Bridging gaps between ergonomics and creative design: a pedagogical experiment

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Abstract. In this paper, we describe a large-scale pedagogical setting involving groups of students from different profiles gathered around a real-scale design project (re-shaping the waiting room of a mental health center). Ergonomics students' main task is to analyze the needs and real activities of end-users; high school students' task is to propose inspiring design tracks; interior architecture students' task is to produce the design project; industrial drafting students' task is to realize execution plans while construction students' task is to implement the project on site. This communication more precisely focuses on the role of ergonomists in the setup, describing their intervention and the practical and pedagogical innovations put in place to help them face the various challenges encountered during the project, namely dealing with the temporal constraints of the intervention, documenting and observing a sensitive situation and involving end-users to make them heart of the design process. The paper concludes with feedback gathered from the different stakeholders.

Keywords: Creativity, ergonomics education, co-design

1 Introduction

This paper addresses the crucial issue of training ergonomists to intervene in design projects. This is an important issue as ergonomics is brought closer and closer to design. Firstly, although the link between ergonomics and design has been at the very core of the discipline since its birth, the explicit claim of the central role of ergonomics in innovation projects remains relatively recent (Brangier and Robert, 2014). Ergonomic practitioners must therefore be equipped to deal with unknown areas and complex, ill-defined design problems that go beyond the correction of existing elements or the mere criticism of projections made by others. Secondly, the field of design has become significantly closer to the concerns of ergonomics for several decades. The place of the users as well as a certain form of empirical approach in understanding their activities have been more and more precisely formalized in fields such as User-Centered Design (e.g. Vredenburg, 2003), Interaction Design (Rogers, Sharp & Preece, 2007) or Design Thinking (Cross, 2006). That way, one has to observe that designers tend to expand their roles towards missions traditionally taken care of by

ergonomists. We consider this link between ergonomics and design to be an essential condition to insure to end-users a central place all along design projects (Charrier et al 2013). Thirdly, our practical experience has shown us that, in order for ergonomics propositions to be heard by design collectives, it is necessary for ergonomists to go beyond traditional high-level and abstract recommendations or formal use scenario. Ergonomic recommendations rather need to be instantiated in concrete proposals, conveying both implicit recommendations and practical exemplifications. It is precisely the expression of concrete, innovative and appropriate ideas that is the subject of creative design processes. Finally, creativity is a core issue of users' involvement in design. Through the fine understanding of creative processes, and by being able to mobilize creative methods, we can involve users in co-creative processes, which constitute an extension of participatory approaches in design and, therefore, a pathway to innovation (Sanders & Stappers, 2006).

Yet, altough these points are key for the education of young ergonomists and professional practicioners, it is clear that French and Belgian ergonomics training courses allocate limited time to immerse students in real-scale design projects. It is therefore necessary to develop effective and relevant settings to enable students develop their abilities and equip them to take action in concrete design situations. This communication builds on this observation and paves a way towards this goal.

In this paper, we describe an inter-disciplinary teaching experience conducted in Liège, Belgium, that provided students in ergonomics with the opportunity to fully immerse themselves in a design project and to make substantial contributions to this project. To do this, we took the opportunity offered by a real-scale interior design project, on a real site, spanning two academic years and bringing together students of various profiles in order to address the issue in complementary ways: starting with a broad exploration of the problem and leading to the concrete realization of a construction site. We detail the general process and focus on the actions of ergonomists. In particular, we address three challenges of the setting young ergonomists had to face, namely the time constraints linked to the intervention, the documentation and observation of a sensitive, mental-health related situation and the involvement of end-users at the very heart of the design project. We detail the original solutions brought to address these issues: co-construction of the intervention by students and teachers; close collaboration with design students; mobilization of data physicalization devices and set-up of an original participatory creativity workshop. We conclude with feedback from different stakeholders.

2 The Setting: principles et objectives

2.1 Global project structure

The workshop is part of the European Interreg project THE! - Technology for Healthcare Education. It aims at involving different profiles of students (from high school to higher levels of education) around a real-scale healthcare design project. The chosen site is the waiting room of a mental health care center in the Liège area,

needing some architectural redesign. This concrete situation offers several added-values. First, the scale of the project is particularly relevant, the reduced size of the space making the design project realistic enough given the limited time scale of the educational setting. Second, the project is rooted in the field of mental health, which enables the involvement of students from various fields, including paramedical and psychology disciplines. Third, the problem is rich enough to require the intervention of ergonomists in order to fully understand the variety of situations at stake as well as to analyze the complex activity of different actors (patients, health staff, administrative staff).

Different groups of students were involved in different phases of the project, with particular objectives:

— high school students (educators and paramedical sciences options, about 50 students) were in charge of the upstream exploration of the problematic and the proposal of design tracks;

— a group of 9 students involved in a Master in ergonomic psychology at University of Liège were asked to analyze the users' needs and activities, to participate to the preliminary design phases in collaboration with interior architecture students, and to conduct a participatory approach involving the professionals of the health care center;

— A group of 12 students from the Saint-Luc faculty of Arts, interior architecture option, were responsible for drafting the design project, in collaboration with the ergonomists and end-users;

— Students from a technical high school in industrial design were in charge of producing, on the basis of the architects' plans, the technical blueprints necessary for the implementation on site (execution plans);

— Eventually, students from a technical high school in construction option were in charge of the construction site itself.

The phasing of the pedagogical setting is presented as follows (Fig. 1):

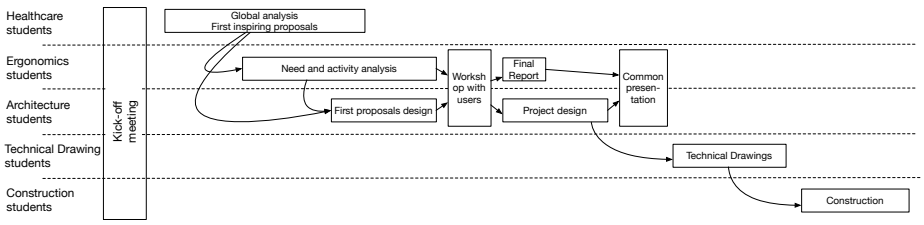

Fig. 1. Phasing of the pedagogical setting

In this paper, we focus on the intervention of students in ergonomic psychology, and their close interrelationships with interior architecture students and users.

2.2 Ergonomists students' role and intervention

Educational goals

The time span devoted to the ergonomists' intervention has been limited to roughly 30

hours, given the academic framework of the "Design Ergonomics and creativity" course. In this very short time, teachers pursued the following pedagogical objectives for their students:

- Discover the design process, its main complexities and the place ergonomics can play (acting *on* the project and *in* the project, Béguin, 2004);
- Collectively construct and carry out an upstream ergonomic intervention in regard of a concrete design project, to feed it with relevant inputs, and to include an important empirical approach of the field in order to analyze real situations and needs;
- Work closely with designers and develop skills and abilities to act in multidisciplinary contexts.

The main difficulty of this educational setting lied in the balance between its real-scale, real-time ambitions and the limited temporal resources at hand. Reaching this delicate balance required building an efficient, fast and relevant process in which students were directly projected in hands-on, rich learning situations.

Methodologies

To this end, the ergonomic intervention was co-constructed right at the beginning of the project by both the teachers and the entire group of students. This co-construction of the intervention enabled students to appreciate the stakes of an ergonomic intervention and the constraints of a real-scale design project, nurtured by rich debates conducted about the methods to be mobilized according to the different constraints. The complementary expertise of teachers involved in this co-construction (one with a background in ergonomic psychology, another with a background in architectural and building engineering) also helped save time and take into account the practical constraints of the intervention, not always clearly identified by students. The joint implementation of a single intervention was chosen (rather than a work conducted in subgroups), keeping in mind the need to efficiently pool resources to ensure a consistent empirical documentation of the situation while dealing with low time volume.

The co-construction of the intervention resulted in the following actions, as carried out by the students while being closely supervised by the teachers:

- First, the mapping of actors and their key challenges (i.e., social analysis of the demand, as described by Folcher, Bationo-Tillon & Duvenci-Langa, 2017) in order to better understand the project's and actors' main issues;
- Second, a short summary of the state of the art about relaxing technologies and spaces, according to the project's initial brief and context (re-shaping a waiting room for a mental health care center);
- Third, an analysis of activities and needs expressed by the mental health care center staff, provided through semi-structured interviews as well as in situ observations;
- Fourth, an investigation of the activities and needs of the health care center patients, conducted through various complementary methods given the situation sensitivity (ethical challenges; necessity to respect anonymity; difficulty to access every patient in person);
- Fifth, the design of personas based on these data;

- Eventually, the preparation and animation of a creativity workshop involving different actors, namely the architectural students and the mental health care center staff.

Ergonomists students' contributions

The ergonomics students, through their intervention, made several significant contributions to the design process. First, through the stakeholders' mapping, preliminary interviews and patients' survey, they were able to build a list of relevant issues to nurture the design process, as well as to document preferences, direct and indirect suggestions from patients and staff members themselves. The state of the art and the interviews helped creating a list of design criteria to be considered in the project. Their in-situ observations made possible the drawing of a model of the reception path in the center, structuring the understanding of the staff members' and the patients' micro-scale activities. The creativity workshop, with its concrete and rich co-design steps, enabled a detailed sharing of points of view between the staff members, the ergonomists and the architects. Personas, on the contrary, proved to be of little use for this specific pedagogical setting and design project. The project has thus enabled, in a relatively short time and given the reduced scale of the project, to involve ergonomists students in missions similar to the ones conducted in professional settings (Martin, 2004, Beguin, 2004).

3 Results : the design project

The project of re-designing the health-care waiting room (mainly used by patients coming in for consultations) was initially limited to a very short entrance hall but has quickly widened to the entire ground floor as the process proceeded. Indeed, students observed that the space devoted to this waiting area was also used by staff members to pass through and connect to other connected rooms and functions, which offered insights to extend the design process to the entire floor. This way the waiting area revealed not only as a space to "wait", but also as a central place for spatial articulation, in close connection with the act of taking appointments, including crossing paths with other patients and health care professionals and closely articulated with the secretariat. The initial "welcoming steps" moreover extended towards the 1st floor hosting the consultation rooms (through a design intervention conducted directly on the staircase); down to the cellar which use and access were also part of the thinking process and back to a small garden, a short building extension used by the secretariat as well as the archive rooms and the staff kitchen area which were included in the process. A global reflection was therefore conducted in order to welcome and insure the well-being of all types of users (including the staff and its day-to-day working comfort), every individual being considered as a crucial part of a larger system in operation and interaction, where none of the sub-components should be ignored.

4 Challenges for the ergonomists

The required setting involved three important challenges:
─ How to build in a very short time (the time of a course) an ergonomics intervention in a design project, in which students carry out empirical work, build a multidisciplinary collaborative approach, and fully participate to the design project?
─ How to document empirically, in an educational context, a potentially sensitive situation, namely the waiting room in a mental health care center, where patients may suffer from various and serious mental pathologies?
─ How to involve users (here, health professionals) at the heart of a design process? Indeed, we are convinced that, like Sanders & Stappers (2016), the future of design lies in the participation of users in design *ideation*, and that ergonomists have a specific role to play in this implication.
For each of these questions, teachers and students co-constructed ad-hoc responses, detailed below.

4.1 Temporal constraints and construction of the intervention

As mentioned in section 2.2, one of the possible answers to this timing issue lies in the co-construction of the intervention, involving both teachers and students. Such co-construction constitutes a risk for teachers as it impedes any precise planning before the beginning of the course. To reduce this risk, a fairly detailed analysis of the context is conducted prior to the course by the teachers, and the overall structure of the pedagogical setting, as well as the planning of the sessions, is carried out in close collaboration with the architecture teachers.

A second answer to deal with this ratio issue between "relevance of the intervention / low temporal resources" lies in a close collaboration between ergonomists and interior designers. The students indeed engaged in an iterative process consisting of short empiric phases on the field on the one hand (followed by rapid analysis to document the target situations), and frequent face-to-face or online meetings with the interior architects students on the other hand (in order to adapt empirical methodologies in regards of the architects' needs and their first design ideas). This coupling was conducted very tightly to ensure collected data to be of real use for the design process, the students in interior architecture having themselves been involved in some field observations. In addition, the multiplication of collaborative meetings also reduced their formal, academic character and helped saving time as well as, more importantly, ensuring an common understanding of each-others' respective constraints. The architectural students were this way able to grasp the stakes, methods and benefits of an ergonomic intervention, while ergonomics students were able to get into the heart of a design project, to grasp the ins and outs, and to understand the process dynamics. Establishing this common understanding constitutes one of the most complex educational objectives to be pursued, and is very much dependent of the students' motivation and willingness to cooperate.

4.2 Documentation of a sensitive and complex situation to observe

The project involves the observation and documentation of a particularly sensitive and complex situation: patients with mental disorders waiting in a tiny entrance hall before consulting a therapist. Indeed, direct observation is outlawed because the place is small and the population difficult to observe; interviews raise delicate questions of privacy, while questionnaires were already implemented in the past (by the health care center staff) but without success. In order to collect data useful for the design while proposing an engaging participatory vector for the people, and without interfering with delicate situations, ,a data collection approach in tangible and situated format was proposed. Patients into the waiting room were invited to answer short questions on physical panels and devices presented in engaging formats. This approach, following the trend of data physicalization (eg Huron et al., 2017), consists in transforming intangible data into tangible, easy to handle, observable and engaging objects. In this context, the students constructed several rudimentary devices (see Figures 2 a, b, c) that were placed in the waiting room for a week.

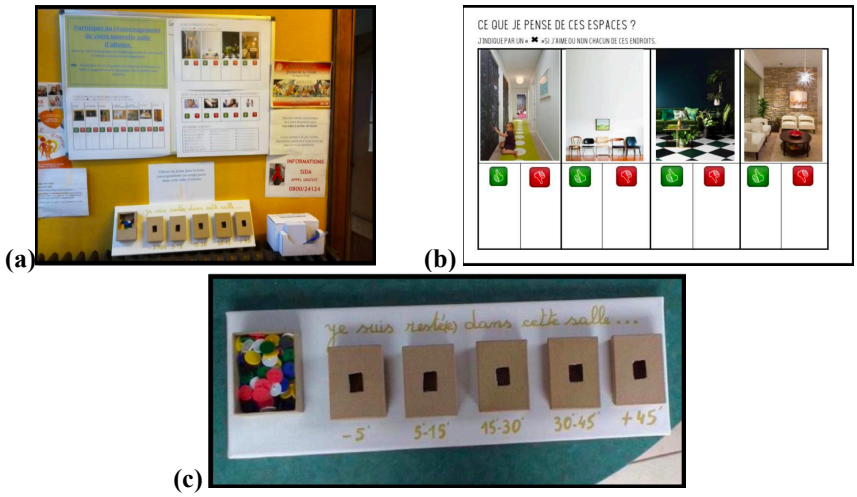

Fig. 2. (a) whole installation; **(b)** Panel asking patients to evaluate possible ambiances of waiting rooms. Patients were invited to stick a sticker in front of the different photos, according to whether they judged these atmospheres pleasant or not; **(c)** device for collecting the time spent in the waiting room. Patients, when leaving the center, were invited to put a token in the appropriate box depending on the time spent.

According to the health professionals, the presented devices enabled patients' engagement, which is difficult to obtain by other means. The design of these devices and the following data analysis is no more complex than for a questionnaire. The students were able to experiment this innovative way to collect data, compatible with the temporal, pragmatic and ethical constraints related to the field. Nevertheless, many additional efforts should be made in the same vein to improve data acquisition: at this point, students have proposed only very rudimentary devices, consisting mainly

of panels on which information can be sticked. An extra effort could be made to work on building more elaborate, visually convincing physical devices.

4.3 The involvement of users directly in the project

The construction of such an intervention requires involving the users, limited here to health professionals for ethical reasons, in the project. This was done in two ways. On the one hand, in a traditional way, ergonomics students validated their recommendations with the users in the context of formal encounters (interviews, meetings). On the other hand, and in a more original way, the professionals were directly involved in the project via a creative co-ideation workshop mobilizing tangible expression supports (1/20 scale mock-ups) built in collaboration with interior design students. This type of setting has already been mobilized previously (Dorta & Safin, 2014) and has shown its effectiveness in supporting interdisciplinary collaborations for space design.
This workshop brought together three groups, each composed of interior design students, ergonomics students and mental health center professionals. Each group was invited to contribute to three projects, defined according to three scenarios, and was equipped with pre-built mock-ups, made by the architect students:
─ The first project was based on a constrained scenario: the re-design concerned only the waiting room area (as suggested in the project original brief), the proposal was already relatively achieved at the time of the workshop, and the mobilized mock-up had a relatively high level of detail and realism (see Figure 3a);
─ The second project, on the other hand, proposed to use an ideal scenario: the ground floor of the building could be entirely remodeled, without taking into account nor the building structural constraints or the costs. The goal here was to explore in depth the needs of users. During the workshop, the mock-up provided by the students was sketchy (Fig. 3b), and the project was poorly defined, leaving much space for ideation;
─ The third project was the intermediary between the two first ones: it was possible to reassign all the functions between spaces of the ground floor, but without affecting the structure of the building. The model was also relatively sketchy (Figure 3c) ;

Each group worked three 30-minutes sessions. Each session concerned a different project, and the group had to reflect on the project at hand by modifying the in-process mock-up, sometimes pursuing the work started by the previous groups. Everyone was thus able to act and position themselves on the three projects.

The work on physical models proved to be effective in instantiating concrete proposals, but also in discovering unsuspected contextual aspects, unexplored constraints as well as in bringing out elements related to the users' work activity which had not been previously identified. Moreover, the open, scalable and easy-to-handle nature of the mock-ups triggered participation of all stakeholders, and not only the designers which are usually the only ones used to represent the spaces and to work on them. Ergonomists and users have thus been able to propose really strong proposals in the different projects.

The three models were of a different level of completion and accuracy. We observe, however, that the simplest model and the least developed scenario (project 2)

were the most conducive in generating rich discussions, engaging everyone and generating innovative proposals.

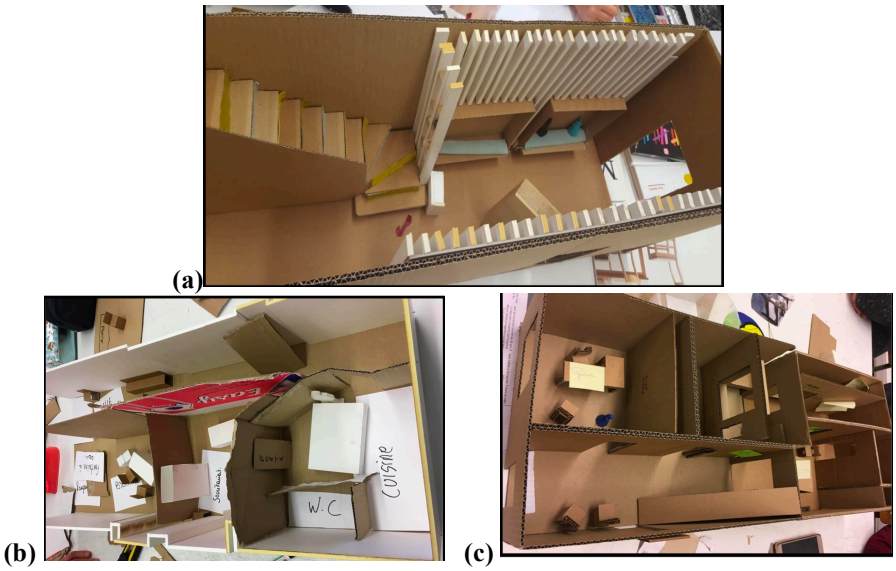

Fig. 3. Mock-ups of the three projects before the workshop

5 Critical feedback from project's stakeholders

At the end of the project, each project stakeholder was invited to openly share some feedback about the whole design process and/or pedagogical setting.
The interior architecture students mentioned the richness of working in close collaboration with ergonomists, and how this collaboration as well as their direct participation to field observations helped them understand the issues and the progress of an ergonomic intervention. Before any encounter with the ergonomists, those students had been sensitized to the challenges of collaborative design and to the necessity to opt for a "meta" point of view while working in larger groups. They were also invited to themselves conduct some deep context analysis, but the expertise and methodologies of ergonomics students supported their own approach. Such a multidisciplinary collaboration, involving students from various disciplines on a single project, helped them all to mutually understand the extent (and limitation) of their own skills and to identify why, and how they might need each-others' expertise.

The mental health care center staff judged the students' analyses relevant and the design proposals appropriate. They especially appreciated being involved in the heart of the project through the co-ideation workshop, and therefore managed to find additional funding to extend the project initial scope and to implement some of the students' proposals

From the teachers' point of view, the pedagogical setting was successful. The strengths mainly relate to previously mentioned key aspects, namely the highly coupled collaboration between ergonomics and architects students, the co-construction of efficient data collection processes given the time constraints and the involvement of users at the heart of the design. In particular, data physicalization devices and the creative co-ideation workshop proved to be very relevant. Nevertheless, several criticisms can be made on the setting, to improve its pertinence. The data physicalization devices could have been further developed. Their design may involve a creative design thinking process that can also be part of ergonomists' learning. Given their potential, it would be interesting to spend more time on these devices. Likewise, the creative co-design workshop was very informative, and was a nice closure to the pedagogical setting, but lacked a more structured data collection. A more formal and systematic analysis of the needs, proposals, contextual elements evoked by the users during the workshop on basis of the three mock-ups should have been implemented in order to further nurture the design project. Conversely, the multiplication of methods mobilized by students induced sometimes superfluous work. The personas and the state of the art proposed by the students, for instance, finally had little impact on the workshop, the project or the process.

Ergonomics students, eventually, were invited to formulate a formal feedback on the pedagogical setting individually through a written report. All students provided a positive overall opinion of the project. They evoked pleasure and pride in having accomplished this project.

Moreover, they spontaneously mention in their reports the following elements. All students (9 out of 9) emphasized the interest and pleasure of working on a real project. This type of achievement is not usual in their training, and is considered very rich and motivating. The students (7 out of 9), however, stressed difficulties related to the project's temporal constraints: the timing was considered globally too short given the scale of the project, the sessions too rhythmic, and this temporality was hardly compatible with the calendar constraints of the architectural and the field partners.

About the collaboration with all the students involved in the setting (including high schools students), only (1) ergonomics student highlights the richness of the interactions, while (5) students highlight the difficulties to collaborate with all the partners. In particular, the kick-off meeting was overall (5) deemed unsatisfactory, occurring too early in the process, days before a first field observation could have been organized (see fig.1). On the other hand, relations with architecture students were judged in a very positive way by (8) students, although some of them point out difficulties of coordination (3), a genuine collaborative work starting too late in the project (3), and a collaboration somehow unilateral (1), as one student regretted not having been involved slightly more in the design of projects before the creative workshop. The group work with nine peers was considered globally unusual and complicated (6) although some students (2) felt that it was rich and worked well.

Data physicalization devices have been positively mentioned by (5) students, although some (3) regret that they had not been worked more in-depth and had not been left in the field for a longer period. The co-design workshop was also judged in a very

positive way (6), both for the concretization of the ideas and the multidisciplinary exchanges it offered and for its closure character in regard of the conducted empirical research. Some students (2) yet regret not having taken a more active part in the preparation and animation of the workshop itself.

About the educational structure of the course, the students (4) underlined the interest of having a non-directive accompaniment and spaces of freedom, where the teachers "*alternate between two postures: peers and experts*", allowing them to build themselves methodologies and data collection tools as professionals would do. Nevertheless, some of them (2) point to a lack of clarity and information about the expectations and difficulties in coordinating with teachers between sessions (2). The balance between theory and practice was also positively emphasized (5), as well as the complementary backgrounds and expertise of teachers, both in the field of ergonomics and architecture (5).

Finally, in regard of their learning process, the students underlined how they appreciated to discover the field of the design "*from the inside*" (4); took note on how their knowledge of the ergonomist's job progressed (5); how the course changed their point of view on the creative process (3); how they learned to collaborate in a multidisciplinary way (4) and how they had the opportunity to integrate and apply more theoretical knowledge learned in other courses (4).

6 Conclusions

Professional ergonomists are very frequently involved in design projects. It seems evident that education must prepare them for it. However, design projects, especially in architecture, spread over a long time, appeal to many actors from different backgrounds, and process by a co-evolution of the definition of the problem and the solution: as ergonomists bring information, the project evolves and new issues raise. It seems therefore necessary for ergonomists and designers to work together. This is the goal pursued by the educational framework and pedagogical setting described in this paper.

The project was ambitious and successful from various points of view, especially in regard to the pedagogical objectives: working on a real situation, with professional deadlines, in a collaborative and inter-disciplinary way seemed to really unfold deep learning and evolution of viewpoints when it come to ergonomics intervention, design and creativity. Of course, such a setting, as it also helps learning about collaboration, does not come without some coordination difficulties. In addition, several improvements can be made in future editions, particularly with regard to the organization of the different activities and the temporal structure of the setting. These difficulties, however, seem to be inherent to one of the major pedagogical challenges of the setting itself: that of letting the students build their own intervention, side-by-side with the teachers.

7 Acknowledgment

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