User-centred design for industrial designers

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ABSTRACT
The association between human computer interaction methods within traditional design methods is presented in this paper. The engineering degree of industrial design and product development is composed by subjects and an international mobility program that facilitates this relationship. For this reason the role playing model is used with the aim to work with multidisciplinary teams. This paper shows study cases of interactive systems: design, prototype devices (vibrating bracelet) and evaluation of small interfaces (Tablet PC) and the assessment of this teaching experience.

Categories and Subject Descriptors
H.5.2. Information interfaces and presentation: User interfaces – evaluation/methodology, user-centered design.

General Terms
Measurement, Design, Human Factors.

Keywords
Role playing, interactive systems, usability.

1. INTRODUCTION
Within the engineering degree in Industrial Design and Product Development at the technical school of Vilanova i la Geltrú, we have been working on the inclusion of human centred design methodologies inside the curriculum for the last four years. In the first academic year, we have an "Accessibility and Innovation" subject where students follow the model process engineering approach by Toni Granollers [1] taking into account the design of interactive systems and design for all approaches. During the third academic year, there are a set of subjects in user centred design. The subjects are: "Human-System interaction", "User centred design and inclusive design" and "Usability and accessibility engineering". The "Human-System Interaction" subject shows the basic methods and tools from the point of view of interaction design. Finally, during the last academic year, these engineering design students have the possibility to begin the International Design Project Semester beside international students.

The *International Design Project Semester* (IDPS) is an innovative training program which addresses the new professional demands that future engineers will need to face. The program focuses on industrial design and adheres to the learning outcomes established by the European Higher Education Area. The IDPS is one-semester course designed to train third-year industrial design engineering students to work in international teams. In the IDPS, an international team of students works on a real-life project. The IDPS has two complementary parts:

- **Courses** (12 ECTS): Four core courses are offered during the semester. Each of these is made up of 20 contact hours plus assignments and a final evaluation.

- **Final degree project** (18 ECTS): During the semester and under the guidance of an academic tutor, an international team of four to six students works on a real-life project.

The following courses are included in the IDPS study program: Eco design, Social Sustainable Design, Human Centred Design, Visual Business, Graphical Visualization of systems, Minding the gap and Spanish language for Foreigners. The IDPS will enable students to apply technical knowledge acquired during the previous years of their engineering education to real, practical projects. The program also offers the opportunity to learn to work in teams in an international and multicultural atmosphere, similar to that found in many companies nowadays.

In the current edition of the IDPS program, the 14th engineering students came from Europe (Denmark (1), Sweden (2), Ireland (2) and Spain (2)); and Latin-American (Brazil (3) and Mexico (2)).

With the objective to reduce the gap between the research activities of industrial designers and the Human Computer Interaction HCI materials and methods, a Human Centred Design (HCD) subject is presented in the second section of this paper [2], [3]. The third section explains the use of the role playing model inside the Human Centred design subject. This model increases the interaction between designers, users and stakeholders. In this section, we show that is possible to include user experience aspects and measure the system usability scale to the design of new products. The fourth section explains the set of final projects inside the IDPS program and the relationship between the contents of these projects with HCI. The fifth section shows details of a final degree project related to the design of small screens. In this sense, an informal evaluation study of three tablets PC is presented with the help of three designers in the role of

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facilitators and nine industrial designers in the role of end-users. Finally, conclusions and future lines are shown.

2. HUMAN CENTRED DESIGN SUBJECT

Engineering students are spared into three groups attending that they are just arrived to the Technical School and they must work together in the IDPS project along with the normal semester (February to July). The HCD course was developed as a three day intensive subject (February 2013) with a total number of 11 engineering students (Industrial Design, Business Management). The criteria for the group composition are: one HCD group has the same members as a IDPS project group; no more than one nationality in the same group; mixing male and female students inside a group; grouping multidisciplinary engineers together. The previous background in HCI is low. Some of these students show basic knowledge of human factors and ergonomics, however there is a lack of knowledge in HCI methods, specifically in the concept of model process engineering (software engineering), evaluation methods, user experience and usability. For this reason, the aim of the HCD subject is to show basic methods and tools of HCI and project the relation of HCI and design beyond the subject. In the context that future design engineers understand that they can include the human centred design approach along their professional activities.

3. STUDY CASE IN THE CLASSROOM: ASSISTIVE TECHNOLOGY

Some case studies were considered in the application of role playing model in the classroom. We show a study case in assistive technology.

3.1 Study case 1

This study case has three steps:

- A Discussion topic: Design of a vibrating bracelet for deaf people and hard hearing people. This is a portfolio supplied by the teacher of two pages.

Role assignation: the group 1 in the role of End User; the group 2 in the role of Industrial designer; and the group 3 in the role of Services Enterprise.

Before beginning: It is necessary to define important aspects of deaf and hard hearing people (group 1); to develop a prototype of a vibrating bracelet (group 2); and make a list of services for deaf people (group 3).

Next step: it is necessary to prepare a report and an oral presentation

- B During the role play: The instructions are: Listening to the other role players. One can attack and defend (please, be polite) and discuss. Try to use expressions for expressing opinions, interrupting, agreeing:

“You’re right; I’m afraid, you’re wrong, In my opinion, I’m afraid I disagree, Can I add something here?, Whatever you say.

- C Final Assessment. Interaction between different role players, peer assessment and the quality of the final report are considered.

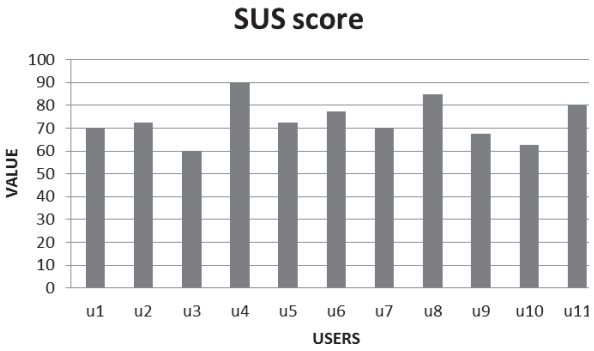

Figure. 1. System Usability Scale

3.2 Satisfaction questionnaire

The vibrating bracelet designed by group 1 allows us to prepare a satisfaction questionnaire. In this work, we are using the System Usability Scale (SUS). The SUS system usability scale is a set of 5 -point-Likert questions with a final score (from 0 to 100) that allow us to measure the user satisfaction [4]. The Figure 1 shows that nine out of eleven students have a score above the value 70.

3.3 Teaching group skills

From the point of view of developing a teaching approach to group skills we are following the Teamwork evaluation form from Lingard and Barkataki [5]. Within a group, the member 1 shows a poor communication compared to other group members, however individual assignments on time completed; member 2 shares knowledge with others between human factors and the industrial design relationship; member 3 shows ability in the oral presentation with a good synthesis in relevant aspects of end-user role and early feedback to the rest of the class; member 4 has ability in prototype development. With the aim to define the user requirements, the group 2 shows good interaction with the group 1. In the group 3 we observe a positive attitude to do research and gather relevant information.

4. FINAL DEGREE PROJECTS

In the current edition of the IDPS program and the European Project semester (EPS), the total number of projects is ten. Students have four months to develop the project within a continuous feedback by a teacher, industrial supervisor or research supervisor. “The autonomous acoustic buoy” is focused on the electronic development of an acoustic buoy and is not related to HCI. “The Motorization and improvement of a wheelchair” follows the classical point of view of an engineering project: when the wheelchair prototype is finished then it is used by a child with motion impairment. “The Chloride reduction from brackish water by hollow fiber supported liquid membranes (HFSLM) using ionic liquids as a carrier” project is related inside the chemistry domain and it’s not related to HCI. “The outboard electric propulsion” project is related to the design of an electric propulsion system for the local fishing industry. This project includes a chapter related to ergonomics (anthropometrics dimensions of arm and hand) related to the use of the outboard system. “The Creating a new urban element to turn Vilanova i la Geltrú into a Smart City” project is focused on the creation of an electronic urban node. The second part of this project is

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developed for industrial designers and takes into account a user-centred approach (display design, ergonomics considerations related to anthropometric dimensions of Spanish population, meeting with experts, surveys to the citizens). “The WC cubicle” project takes into account the design of a WC cubicle for Indian population within the collaboration of a famous Spanish enterprise leader in this domain. In this sense, the industrial designers analyze cultural, technological and emotional aspects (acceptation of the product, empathy). Finally, “The design of small interfaces” project follows a human-centred approach in the context of improving the relationship between design methods and HCI methods and within the collaboration of teachers from three Catalan Universities. This project has an analysis requirement phase (context, market, trends in the design of small interfaces), a development of a guideline for small interfaces and informal usability studies with Tablet PC trying to understand and find usability problems.

The next section shows an example of a study case inside this last project.

5. STUDY CASE IN THE LABORATORY: THE USE OF TABLET PC

Informal evaluations can be done with nothing more than the knowledge you have from experience [6]. In this section the method called “five steps to a user-centred expert review” is applied in the study of three Tablet PC usability problems. The Tablet 1 is a low cost 5” Spanish Tablet. The Tablet 2 is a famous and competitive 7” Tablet. The Tablet 3 is a 8” Tablet adapted to the use of e-book readers. The authors of this method are Whitney Quesenbery and Caroline Jarrett [7]. The method follows a sequence of steps for example “Who is using this product” and aspects related to relationship, conversation, interaction and appearance. This informal method is important because it is the first step to establish a relationship between the industrial design methods and the HCI methods [8]. [9], [10], [11], [12], [13], [14], [15], [16], [17] and allow us to prepare a usability study.

The objective of the test is to study the quality use of a Tablet PC. The focus is not on the user behavior, but on usability problems with the use of new technologies. The users group that was interviewed was a sample of nine EPS students with ages ranging from 19 to 25. Each student had to complete 16 tasks on each tablet. The set of tasks are:

1 Turn on
2 Unlock
3 Change the language; put the Tablet in Spanish
4 Change the language: put the Tablet in English, after continuous the test with the Tablet in English
5 Connect on the internet
6 Open Youtube from the browser
7 Search for the video: “IPhone 5 (parody)”
8 Open this video
9 Increase the volume
10 Put it full screen
11 Stop the video and exit internet
12 Access to the rest of applications of your Tablet
13 Take a photo with the camera
14 Access to the gallery folder
15 Close all applications
16 Turn off

This experimental test has a duration time of 45 minutes and was developed in laboratory conditions in May month.

At the end of the tasks, users answer 7 questions about the hand posture preference, the preferred tablet, finger part used, etc. From the point of view in the assessment of these devices, here we have the comments of three users:

> - “The Tablet3 was easy to use and handle with minimal icons and a clear simple interface. However it takes time to turn it on”;
>
> - “With the Tablet1 it’s a totally different interface thus it was much harder to figure out the buttons, but once one does that, you get used to it quite nice”;
>
> - “The Tablet2 was very similar to the Tablet3 as I was able to pick out and recognize applications. However they were much smaller and sometimes hard to see and press. This Tablet does not have a back camera”.

A discussion with users shows that the weight of Tablet 3 is considerable and is difficult to hold. For one female user the Tablet 3 was difficult to hold with both hands and do the tasks at the same time because she had small hands and needed to do a physical effort with her fingers. So it’s important to take into account some human factors aspects related to the use of the Tablets (the thumb problem, the size of the human hand, the thickness of the index finger).

The 66% of the interviewed users prefer the hand posture “Thumb Extended with Thenar Support”, 25% prefer “Thumb Wrap’ posture” and 9% prefer “Flat Hand’ posture” and 75% of the interviewed users use fingertip, the rest, 25%, use finger pad.

The 50% of the respondents have problems with the size of the targets, the majority think that it is small, against 42% that do not have problems.

The 50% have vision problems with Tablet 1, 17% with Tablet 3 and nobody with Tablet 2, and also 33% do not have vision problems at all.

One of the questions was about the preference of the tablets, and the respondents had to analyze all the information involved and justify it. 58% said that prefer Tablet 2, 34% Tablet 3 and only 8% Tablet 1.

Moreover, 33% of them prefer other devices to complete similar tasks.

Half of the respondents did not have previous knowledge about mobile devices and 75% do not use tablets, but 25% said that depending on the tasks the tablet is not the first choice, for example to work and research. The computer is still preferred.

If we compare the average time of the 16 tasks, the fastest one is Tablet 3 (180 seconds in total), then Tablet 1 and 2 with a similar time (204 seconds).

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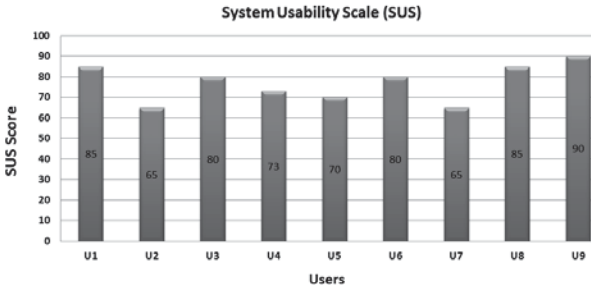

Figure. 2. SUS in the use of Tablet PC

5.1 Satisfaction questionnaire

The SUS was applied to 9 EPS students after they operated 3 different tablets and some conclusions were made based on the data. All students disagree or strongly disagree with this 3 sentences: "4- I think that I would need the support of a technical person to be able to use this system, 8 - I found the system very cumbersome to use, 10 - I needed to learn a lot of things before I could get going with this system". All students agree or strongly agree with this sentence: "5 - I found the various functions in this system well integrated."

The users found some difficulties on the operation of the system because sometimes the interface and what they are supposed to do is not so clear, so they agree that they have to get used to the interface first, and then they can operate quite well. They recognize that tablets are an excellent tool for business, studying or entertainment. The test shows that tablets have an average score of 76.94.

6. CONCLUSIONS

The teaching experience in user-centred design approach for industrial design and product development engineers is presented in this paper. The International Design Project Semester is an academic framework where it is possible to link the capacity to reflect on experience and the development of professional skills. Preliminary results in the Human centred design course show that the use of the role playing model in the classroom can be useful for teaching assessment of group skills.

From the point of view of research projects, the final project presented in this paper shows that is possible to establish a relationship between design methodology and HCI materials and methods. With the use of an informal evaluation of small interfaces (Tablet PC) the authors can detect usability problems and prepare a framework for the development of a guideline for small interfaces.

7. ACKNOWLEDGMENTS

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