

## **THE CHALLENGES OF FUNCTIONAL PROTOTYPES: Trans-disciplinary Projects in Interaction Design**

**Christine Strothotte, Carola Zwick**

### **ABSTRACT**

Design education has to take into account the increasing complexity of today's products. Design concepts have to be communicated with the help of functional prototypes which simulate the upcoming product as realistic as possible. Co-operation with associated professions like electronics and computer science is inevitable. The interaction design group at the University of Applied Sciences supervises trans-disciplinary projects for more than 7 years now and gained a lot of experiences and insight. In these projects we always work on balancing the analytical or „vertical thinking“ of most sciences with the „design thinking“ that is focussed horizontally and cares about synthesizing observations from various fields and therefore is by it's nature trans-disciplinary. The master's programme in interaction design is committed to this challenging kind of collaboration.

*Keywords: Interaction Design, Trans-disciplinary, Design Thinking, Functional Prototypes, Collaboration.*

### **INTRODUCTION**

Designers think about products, and today's products are changing dramatically according to technology and the contexts in which they are used. Most products contain microchips. Therefore, designing modern intelligent products is no longer a question of only hardware but of software as well. The focus of development is shifting more and more away from atoms towards bits and bytes, which have to be designed at the same degree of thoroughness. This can even lead to digital products, which consist only of bits and bytes and are pure software applications. University qualifications for designers are adapting to this change: while technology education for a long time meant principles of welding, countersinking, deep-drawing, etc., today it is broadening to include web technologies, data bases, input and output devices, and basic computer architecture.

Designing interaction in the digital age requires different levels of models: scribbles, paper computers, digital animations, interactive simulation of software, and even combining hardware, such as an input or output device, with simulated software and building a fully-functioning prototype which makes a perfect illusion of the upcoming product.

The educational challenge is to enable designers to master the technologies of a broad field with sufficient expertise in, e.g. electronics, computer science. It requires a special

focus on trans-disciplinary work, which is fundamental for the interaction design group based at the University of Applied Sciences in Magdeburg/Germany.

### **TRANS-DISCIPLINARY PROJECTS**

In our Bachelor's programme in Industrial Design and the Master's programme in Interaction Design, we experienced more than 15 interdisciplinary projects empowering design students to work in teams with computer scientists or electrical engineering students. Some of the teams came up with outstanding results, which were shown twice at the Games Convention in 2004 and 2005, Europe's most important adventure fair for interactive entertainment, hardware and educational software [1].

One such interdisciplinary project, "virtual physics", was a winning combination of serious challenges and fun. Seven design students, four electrical engineering students and five computer science students were faced with the task of developing an interactive, net-based computer pirate's game which can be played by several crews. The particular challenge was that the game had to be designed to operate without conventional input devices, such as a mouse or keyboard.

Each student brought his or her own disciplinary perspective to the team effort, and had to learn to synthesize that perspective with those of the other students in order to ensure the group's success. All phases of development, from conceiving the fascinating game idea, to developing adequate interaction between hardware and software, to producing the fully functional prototype, were dependent on a high degree of interdisciplinary synthesis and cooperation within the group.

This pirate's game was playable by four different teams, each with their own ship and individual steering tool, one or two canons and a capability for hoisting the sails. Because the game was network-based, the various crews and their ships were able to interact remotely. Though crews were operating from remotely distant locations, they were still able to play together in the same virtual 3D world.

Every group was able to produce fully functional prototypes which were not only playable by the developers themselves, but by the audience of a game fair (at least for four days). This outstanding result of a 15-week project was possible only because of the generous support by the local company Impara GmbH, which provided their game engine and technical support.

Although the pirate's game project was a lot of fun, it proved to be one of the most challenging projects our teachers and students ever produced. The motivation of all participants was exceptionally high, mostly because the topic itself is so interesting. Nevertheless, developing a game is really hard work. The degree of complexity is very high, and every single task a real challenge pertaining to interaction design, computer science or electrical engineering. Combining all of the individual task solutions into a single prototype makes development even harder.

The next chapter highlights the question, in which ways the trans-disciplinary projects differ from projects in which only design students are enrolled.

## **CHALLENGES OF TRANS-DISCIPLINARY PROJECTS**

Students who enroll in trans-disciplinary projects are in most of the cases very self-confident, because they choose this particular challenge voluntarily. As far as they work together with students of their own profession, they work either alone or with fellows on a similar level of experience. In trans-disciplinary projects they find themselves in a team with someone who is an expert in a different field, like electronics, which is as essential as their own expertise for the success of the project. This same expert is a freshman in their own profession, like design. This constellation, to work on different levels of expertise, is new and very confusing for most of the participants when the project starts.

When people from different professions come together, their work rhythm, their terminology and their focus within a project is completely different. Finding an appropriate structure within the group, sharing responsibilities and negotiating ideas and concepts is a complex process for mixed teams. We experienced that shared tasks from the beginning with a clear focus on practical work helps a lot to build the team. It increases the responsibility for the success of the team.

The success of trans-disciplinary work requires that team members learn to appreciate the knowledge of others, and to recognize the value of work, which may be different from their own. Therefore, the communication skills necessary to explain their own expertise to non-experts are essential. We promote this by forming the teams very early in the design process and forcing them to present basic knowledge of their own profession to the others without using all this tech-talk, but using instead analogies and metaphors for explaining.

Still agreeing on a procedure within a team and utilizing the specific talent and expertise of each team member seem to be the hardest thing to learn within a projects time frame of 12 weeks. But especially the feedback from alumnis tells us that this learning experience helped them to contribute to team efforts, manage conflicts and successfully communicate their ideas.

## **TRANS-DISCIPLINARY MASTER'S PROGRAMME INTERACTION DESIGN**

Many of the trans-disciplinary projects in the Diplom programme were chosen voluntarily. In the process of introducing bachelor and master's programmes, we took the chance to establish a trans-disciplinary collaboration between interaction design and the associated professions within the master's programme of interaction design. We realized a complete new programme based on all our experience and established our vision of how the emerging field of interaction design can be taught.

The master's programme in interaction design is aimed at graduates from a variety of professions who are attracted by new technologies and their implications for our everyday lives. The idea behind the curriculum is investigating how people are going to interact with newly-designed products in the future. This is much more a question of services around the product than of the actual devices themselves.

The programme has a strong focus on the integration of the physical and the virtual interface. The goal is to design a compelling user experience with the help of

prototypes, which are much more than a design model, but come instead very close to reality and the upcoming product. Therefore, master's students spend fully half of their effort working on projects in trans-disciplinary teams.

Applicants for this master's programme may have a degree in electrical or mechanical engineering, computer science or, most likely, in design. The master's programme challenges all students to gain insight into these related fields and to take advantage of the range of abilities of their fellow students.

### Curriculum

The curriculum takes into account the different backgrounds of the students and offers basic courses in design as well as in related sciences like computer science, electronics and psychology, which are essential for the emerging field of interaction design.

We are developing specific courses in computer science and electronics, which are especially formulated for design students. To describe the basics of these very analytical sciences to people who are more visually oriented, like designers, who often disliked math at school, is a real challenge (see Related Sciences for Interaction Design)

*Table 1. Curriculum of the master's programme "Interaction Design"*

Courses	Term 1	Term 2	Term 3	Term 4	total
Design Basics Design Methods Design Repertoire	4	4			8
Basics in Related Sciences Computer Science Electronics Psychology, Cognition	4	4	4		12
Intersections Innovation   Emerging Technologies Design and Economics History and Culture Evaluation Techniques	6	6	6		18
Projects	16	16	16	10	58
Master Proposal			4		2
Master Thesis				20	20

Projects in the master's programme are focussed on a complex question, which has to be comprehensively answered in a process of design and reflection. All our projects focus on the challenges of integrating new technologies into our daily lives.

Due to the interdisciplinary backgrounds of the project team members, a project does not only result in a design model, but in a fully-functioning prototype. In the "usability

laboratory” these prototypes can be tested in simulated environments. The faculty members responsible for this master’s programme themselves come from industrial design, computer science and electrical engineering.

These projects will be complemented as the main form of teaching by so-called “intersections”, which provide a platform for scientific research pertaining to interaction design. This is the chance to combine the associated professions with the field of interaction design and to find out where they intersect. Students have to provide substantial input into this theoretical and reflective discourse.

## **RELATED SCIENCES FOR INTERACTION DESIGN**

As we mentioned earlier, the related sciences have to be taught in a very practical way. We would like to highlight the syllabus of these courses to explain which particular concepts we have chosen to teach and which practical experience the students gain from their assignments.

### **Basics in Electronics**

During this course the students develop an encyclopedia of interaction. By means of analyzing physical action and develop corresponding reactions in a real or a virtual space, students learn all the basics in electronics [2].

They start with the following questions:

- \_How do I communicate with the computer?
- \_How does the computer communicate with me?
- \_Which output does the computer produce for a particular input?

The course focuses on how to build circuits, on sensors and on the connection between the physical tools and the computer via USB or serial connections.

During the last course, the Basic Stamp/Picaxe-Controller was used as a micro-controller [3]. A program developed in Macromedia Director using an Serial Input/Output Xtra was able to communicate with the micro-controller via the serial interface of the computer.

A series of weekly assignments explored the specific potential of interaction elements like button, switch, slider, dial, and a variety of sensors by creating small interactive installations.

This knowledge and experience was then used by the students to develop an encyclopedia of interaction that both utilized and explained computer input and output channels corresponding to the scope of human perception and interaction. Each student chose a specific human sensory system or bodily extremity, and then developed a visualization to describe its nature and characteristics, as well as its manmade extensions and potential as an interaction medium.

## **Basics in Computer Science**

We propose that, for non-engineers, the theoretical fundamentals need to be embedded into a practical framework. At first we thought we would be able to recommend foundation lectures at the corresponding department. But experience has shown that basic lectures from other disciplines, e.g. first lectures within the computer science department are not suited for designers for several reasons.

First of all most design students remember mathematics back in school as being painful or being too abstract. In addition, traditional foundation courses are starting with basics without explaining the big picture. Thus the basic lectures for master students first need to give an overview of the underlying concepts rather than starting with a specific programming task. This realization led us to develop a special lecture that both supports the typical curiosity of designers and answers the question „what is it good for?“ beforehand to boost motivation.

## **PERSPECTIVES: DESIGN THINKING**

While many sciences are based on analytical thinking, which can be described as vertical analysis, the creative process of designing is a broader approach involving synthesizing observations from various fields and can be therefore described as being horizontal analysis. Since the process of creating ideas is hardly linear, design is sometimes even perceived by those in other disciplines as being stochastic. When students from different disciplines work together, these two worlds and mind sets have the potential to collide. If a project is successful in balancing these two ways of thinking great results can be achieved.

## **ACKNOWLEDGMENT**

We would like to thank all our collaborators during the past years. Especially Michael Ruger, Bert Freudenberg and Maic Masuch from impara supported us in several ways. We appreciate the patience and the dedication of our colleagues from the electrical engineering department, Wilfried Daehn and Dieter Schwarzenau.

## **REFERENCES**

- [1] Games Convention  
<http://www.gc-germany.de/>
- [2] Tom Igoe, Dan O'Sullivan, Physical Computing: Sensing and Controlling the Physical World with Computers, Course Technology PTR, 2004.
- [3] <http://www.rev-ed.co.uk/picaxe/>

## **CORRESPONDING AUTHOR**

Christine Strothotte, PhD, Professor for Technologies for Interaction Design  
Institute of Industrial Design, Department of Engineering and Industrial Design  
University of Applied Sciences Magdeburg-Stendal | Germany  
Breitscheidstr. 2 | Haus 9, D – 39114 Magdeburg | Germany

[christine.strothotte@hs-magdeburg.de](mailto:christine.strothotte@hs-magdeburg.de), [www.design.hs-magdeburg.de](http://www.design.hs-magdeburg.de)