Business Oriented Design of Collaborative Applications

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ABSTRACT
Multi-touch devices and gesture tracking have recently been established as tools for collaborative interactive spaces. Innovative application concepts and applicable scenarios in which gesture-based interaction has advantages instead of traditional WIMP User Interfaces are necessary. In this article, the results of a series of workshops conducted during the last three years are presented. These workshops focused on the creation of innovative multi-touch applications in the domain of tabletop devices. Furthermore, important lessons learned from the setup of these workshops and the arising didactic approaches including their benefits and drawbacks are described.

Categories and Subject Descriptors
K.3.2 [**Computer and Information Science Education**]: Computer Science Education.

General Terms
Design, Experimentation, Human Factors.

Keywords
Natural User Interface, Gesture-based Interaction, Creativity Techniques

1. INTRODUCTION
Multi-touch technology has become a multi-purpose equipment, which is used in different application domains and manifold device contexts, including mobile phones, tablet PCs, tabletops, or display walls [1, 2].

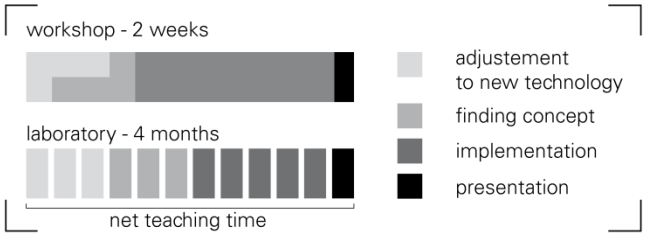

Figure 1: Comparison of workshop and laboratory.

In order to explore the potential of multi-touch, to define use-cases which are predestinated for gestural input, and to expand the field of research for interaction metaphors, we started a series of workshops with students of Technische Universität Dresden in cooperation with the T-Systems Multimedia Solutions GmbH three years ago [3]. Additionally to research and educational purposes for the students, another goal was to find an arrangement which is suitable to deliver high quality conceptual and technological results. Business partners should be given the opportunity for direct mentoring and to get in touch with the participating students – possible future employees.

This business oriented approach was evaluated by conducting a second event, a four-month laboratory, and comparing the results (see Figure 1). In the following sections these outcomes will be described, followed by an analysis of the benefits and the lessons learned from the past installments of these courses during the last three years. Short video demonstrations explaining the resulting prototypes are available online [4].

2. CONCEPT OF STAGES
In the following sections, our approach and the development of the curriculum of the workshops and their practical results will be presented and discussed.

2.1 Stage One: Establishing the Format
In order to deliver skills in the development of multi-touch applications a two week workshop was conducted at the beginning of October 2009 in which students were instructed to find scenarios which particularly benefit from the concept of gesture-based interaction. Although the used technology, a Microsoft® Surface® [5], had impact on the possible use cases for the created applications, the technological limitations were not explicitly revealed to the students. Therefore, the participants were confronted with an innovative technology without being aware of the exact capabilities and limitations of the device.

This approach was chosen to ensure that the students did not focus on technological aspects. Instead, the developed concepts revealed weaknesses of the technology in some parts, but also forced them to overcome these issues by finding creative solutions. Five groups of two students were given advice about implementation details by members of the staff from the university and the T-Systems Multimedia Solutions GmbH, which also provided the hardware.

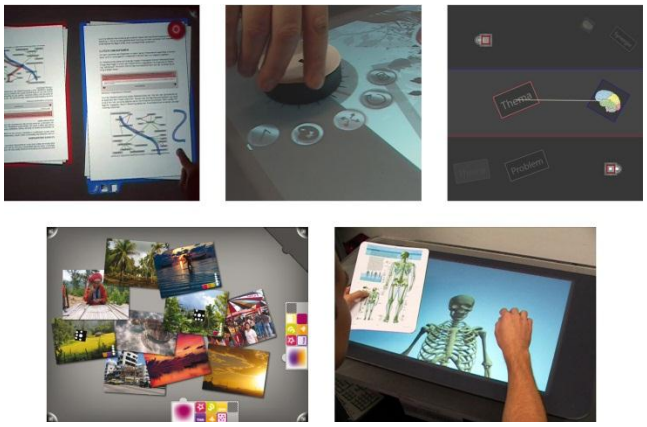

Figure 2: Results from the first workshop in 2009: *SurfaceReader, Tangible Design Helper, MySpace, TagIt* and *NavigaTable.*

The results of this first iteration of the workshop can be categorized regarding the aspects of using the Microsoft® Surface® for collaboration and presentation tasks (Figure 2). The group which developed *MySpace* elaborated the concept of collaborative work containing private and public spaces on the interaction surface. The application *TagIt* focused on sorting and

tagging photos by multiple users employing tangibles to fulfill this task in a playful manner. *SurfaceReader* was set in a more business related scenario by introducing collaborative work on documents with fixed roles for the users and aligned manipulation modes. *NavigaTable* is based on the idea of presenting 3D content for education and identified methods for interaction with three-dimensional representations on a flat surface, which reflects one direction of research within the last years [6]. The scenario of interactive customization of laptop covers was explored within the *Tangible Design Helper*.

Based on the high quality of the results and the amount of research challenges which were raised during the workshop, the event was considered a remarkable success, which was not predictable, due to the short time period in which the students had to find an idea, learn new technologies and implement their concepts. Hence, the workshop was considered to be repeated in the next year. In order to get comparable results for the evaluation in comparison to other teaching methods, a similar but longer laboratory was planned.

2.2 Stage Two: Evaluating Approaches

Shortly after the first workshop, a four month laboratory was conducted and evaluated afterwards. The objectives for the students were similar, although the technology was less strictly predetermined. The participants had the opportunity to choose whether they want to develop with Microsoft® Surface® or xdesk [7]. During the laboratory, open research questions were addressed and concepts for solutions and their implementation had to be created by the students.

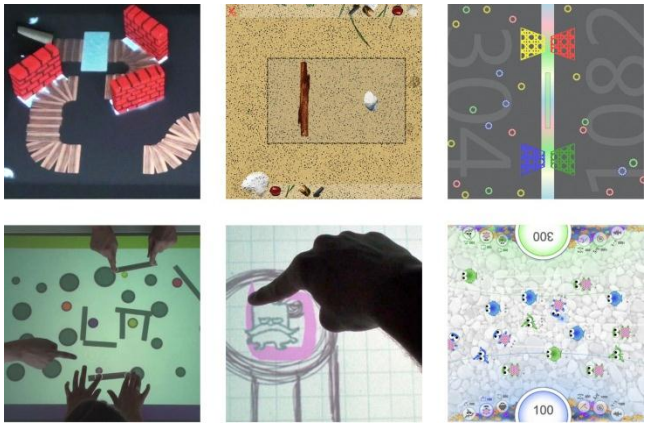

Figure 3: The results from the laboratory: *MarbleRun, Under the Surface, Flip, Scoop, Monsters, MT Tower Defense.*

The results (Figure 3) demonstrate some differences between the concepts of a short, concise workshop and a longer, less strictly organized laboratory. The six groups were assigned different aspects of multi-touch interaction which they should focus on within their application. *MarbleRun* took a closer look at the handling of Tangibles to enhance the physical aspect of touch interaction. Techniques for cooperative searching for objects were presented by *Under the Surface*, while *Flip* focused on sorting of objects. Dexterity and precision are interaction attributes which *Scoop* and *Monsters* explored in a playful manner. Finally, *MT Tower Defense* emphasized the aspect of cooperative play within multi-touch applications. The observation that the workshop didn't produce any gaming concepts, while during the laboratory the students focused solely on this aspect of multi-touch can be explained by the small amount of time available in the workshop, which may have restrained the students to work on conceptually and technologically complex problems. Additionally, a laboratory has the advantage that the acquisition of technological skills is more flexibly organized during the course (cf. Figure 1).

However, the laboratory concept lacks some features which have proven to have positive effects during the workshop. Time pressure and continuous work on a specific problem led to a more focused workflow within the teams and did have positive impact on the overall quality of the results. Additionally, the workshop teams were better organized due to the fact that every team member had to focus on a specific task in order to meet the deadlines during the workshop.

2.3 Stage Three: Enhancing the Workflow

To enforce the exploration of more sophisticated and complex problems, minor changes were applied during the second iteration of the workshop in October 2010. One issue had been identified in the time-consuming reports which incorporated a short presentation of the progress the group had made nearly every day. These reports were replaced by individual consultations in order to minimize the time spent for organization and feedback per group.

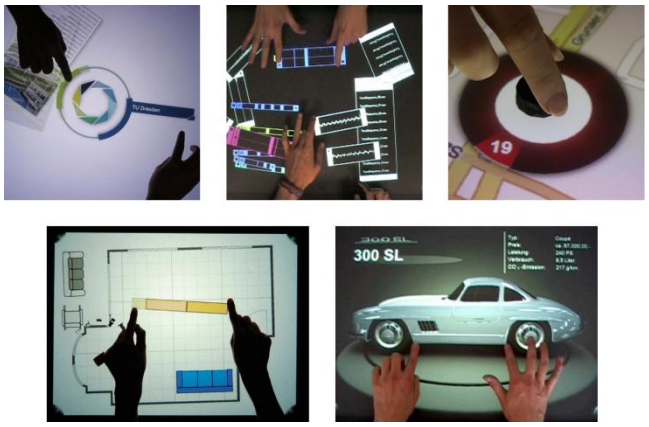

Figure 4: The example applications realized during the second iteration of the workshop: *DRESDEN-concept, SampleSurface, Time-Table, FurPLe* and *ShRoom.*

The workshop results reflect that these measures partially influenced the complexity of the realized ideas in terms of a higher variability of implemented concepts (Figure 4). The range of application domains contained presentation, planning, and composing. *DRESDEN-concept* was designed as an information visualization of the structural concept and future research cooperation of Technische Universität Dresden, especially regarding the background of the application as university for the German Initiative for Excellence [8]. *ShRoom* represented an interactive showroom for the automotive industry, combining high quality 3D content with semantic browsing concepts. *Furple* demonstrated the capabilities of a multi-touch device in terms of arrangement planning for furniture in a sales scenario, whereas *TimeTable* focused on the idea of collaborative route planning in the tourism domain based on an interactive map containing a time table and nearby points of interest. *SampleSurface* incorporated the idea of collaborative arrangement of audio samples for experimenting and playing with music composition.

The focus of the workshop switched towards the research of gestures and metaphors for complex actions due to the enhancement of the technology [9]. Especially the aspect of simultaneous touches including the usage of both hands for interaction with the device was treated in most applications.

2.4 Stage Four: Introducing New Aspects

Although the results of the second workshop presented numerous innovative ideas, the question was raised how the ongoing technological advancements could be integrated in the didactic concept of the course. Among current research, three-dimensional objects as input devices for touch are discussed [10, 11]. Another idea is the combination of depth sensing technologies with touch recognition [12]. Therefore, it was decided to modify the technological foundation of the workshop and motivate the students to elaborate scenarios in which multi-touch and three-dimensional gestures tracked by a Microsoft® Kinect™ can be used either for collaboration or to enhance the interaction concept.

Not every student group chose to apply both technologies, some focused on the traditional approach, another group concentrated solely on the work with depth sensing technology. Due to the more complex technological background the size of the teams was slightly increased for topics which incorporated the combination of Microsoft® Surface® and Kinect™ [13], resulting in groups of up to four students working on one problem. The expansion of the technological focus resulted in a higher variety of application concepts. Similar to the first iteration of the workshop, a tendency towards collaborative scenarios was identified. Therefore, the main aspects covered during the two weeks can be subsumed as collaboration, composing, presentation, and gaming (Figure 5).

Punchinello employs multi-touch and depth sensing technology for a collaborative stage play where the Microsoft® Surface® acts as input device for the director who can place objects and figures on the stage or play sounds using tangibles. The users in front of the depth sensor animate the actors with their body-movements.

SurKiLab introduced a more competitive concept and focused on the differences which result from the different perspective of the user when sitting on a table in contrast to interacting in front of a wall projection. The developed application respects these differences by varying the design of the user interface for multi-touch and three-dimensional interaction. The user sitting at the tabletop is presented a top-view of a virtual maze, whereas his spatially tracked counterpart views the inside of the maze. The interaction style of the players can be depicted with the metaphors of the all-seeing commander and the hunter who is running through a surrounding environment, focusing on the part of the scene in his center of view. Therefore, not only the visual presentation is adapted but also the tasks differ between the users. The player interacting with the touch table is assigned with a tactical task, which incorporates placing barriers and thus preventing his opponent from escaping the maze. The task of the Kinect player is to react as quickly as possible to obstacles or dead-ends and to find his way through the maze within a specified time.

The third application, *BodyKinector*, which focused solely on the Microsoft® Kinect™, takes place in a collaborative Virtual Reality scenario. The idea was to track the user and to delegate his movements onto the avatar representing the user in the virtual world. Special gestures triggered actions within the digital environment.

The applications *Neophony*, *Vismo* and *MyFruit* were developed for the tabletop without taking depth sensing devices into account. At the beginning, some of these concepts included the use of three-dimensional tracking for specific enhancements of the touch interaction, but during development the students realized that the combination of two devices which rely on infra-red light causes interferences which could not be solved during the short time period.

Neophony picked up the concept of *SampleSurface*, as described in section *2.3* and tried to find concepts for the generation of sounds from shapes which are recognized by the Microsoft® Surface®. The idea behind the application was to take the infrared-image of an object, which is received by the table when an object is laid onto the surface, and create a sound which depends on the shape of the recognized touch area. Using this approach, sounds could be easily reproduced if the same shape is laid down on the table but also highly randomized for some objects such as a bunch of keys which is put on the table.

The group developing *Vismo* focused on children as users of multi-touch technology. This aspect of touch interaction is only been partially covered by current research and also was not considered within the preceding events [14]. Short games which should also contain educational aspects were implemented and interaction concepts which can be used easily by children were tested. *MyFruit* realized the idea of using the surface within gastronomy and extended it. Therefore the application included not only the design of the application, but also the concept of the whole procedure when ordering at the table by using the Surface to determine which ingredients the drink should be made of.

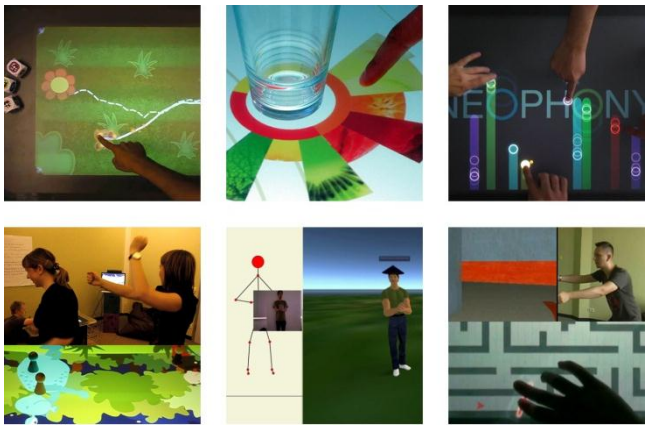

Figure 5: *Vismo, MyFruit, neophony, Punchinello, BodyKinector* and *SurKiLab* are results of the third installment of the workshop.

The results of the third installment of the workshop are less related to each other, as it was the case in the years before, where two topics dominated the event. Reasons for this might be the higher flexibility and higher diversity of used technology caused by adding the Microsoft® Kinect™ as development device. Another point might be that multi-touch has become familiar to everybody and many concepts already exist. Therefore it is easier for the students to estimate what can be achieved using multi-touch technology and what not. On the other hand, it might be more difficult to find new ideas, so that the creative part of the workshop has become more demanding.

3. FINDINGS AND FUTURE DIRECTIONS

As stated in the introduction, the laboratory as more traditional format for teaching served as evaluation in order to make the results comparable in terms of quality and quantity. One finding is that both courses did not differ significantly except for their duration. The results were of similar quality in both courses. The longer duration of the laboratory therefore had no significant impact on the overall quality. Instead, the familiarization with the technology was slower in the laboratory compared to the workshop. On the other hand, the longer duration gave the

students the opportunity to work more intensively on the concepts for their application and think of possible solutions.

In terms of educational purposes, both models have certain advantages and disadvantages that need to be taken into account. The laboratory fits best for specific research problems, while the use of the workshop model is preferable for the cooperation with business partners due to the shorter, concentrated time period.

Another positive point is the embedding of three-dimensional interaction which is related to current research directions [12]. This marks one possible direction in the future which involves additional changes of the concept of the workshop. Due to the higher diversity of technologies involved and the more complex process of training needed, it is planned to outsource the introduction of the technologies, in a short course which takes place before the workshop starts.

In order to evaluate the concepts of the workshop and enhance the collaboration with business partners, the EmplIT (Employability for IT) project funded by ERDF (European Regional Development Fund, project-no.: 1310571015584) has recently been started at the university [15]. Additionally to the aspects mentioned before, EmplIT targets an open, adaptive software framework which is intended to be used in forthcoming courses and supports rapid development of innovative software applications by the participating students.

4. CONCLUSION

This article covers the results of three workshops and a laboratory conducted in the last three years with students. The participants had the opportunity to get in touch with innovative systems and technology-driven companies which participated in the workshop. The workshop concept forms a business-oriented approach which supports the transfer of ideas, knowledge, and technology between university, business partners, and the students. Due to its short duration, the students can focus completely on their specific tasks and demonstrate their potential for quick and flexible problem solving. Compared to this concept, laboratories offer more space for refining ideas and the exploration of complex research questions. In conclusion, both formats have proven to be successful and popular amongst students.

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