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VISUALISING WORKPLACE DESIGN

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ABSTRACT
Design is a learning process and the use of prototyping activities for the sake of learning increases the design thinking, i.e. the dialogue and feedback on ideas. Hence, representations ranging from sketches to different kind of models and animations are recommended to be used as prototypes to mediate user needs and to support communication within the team. Low-fidelity prototyping enables rapid visualisation of ideas, reframes failures into learning, generates perceptual progress and supports creativity. In product design, different visualisation techniques are used to generate and communicate ideas since thinking visually is seen as necessary for innovation.
This paper describes the work of developing a course where you combine the task of workplace design with traditional industrial design visualisation methods like sketching, model making and 3D computer aids. By using the knowledge and experience from product design and incorporate it into workplace design, a process where all parties contribute in new ways could be achieved.
In the course the students start by performing an individual investigation of the present research front for production visualisation by summarizing and analysing a number of scientific articles. A work place design project was then performed where exploratory, explanatory and persuasive visualizing techniques were implemented. Through a creative and constructive collaboration across disciplinary boundaries, Industrial Production Environment and Industrial Design, we have created and implemented a course in an area that has been lacking in our Master Program.

Keywords: Workplace design, layout, visualization, communication, participation.

1 INTRODUCTION

The industrial companies' ability to continuously change and develop work places and production systems is an important prerequisite in order to compete on a flexible and international market. Rapidly changing market demands call for manufacturing systems to be continuously developed. This requires flexibility and effective redesign processes involving contributions from personnel across an organization. Involving stakeholders, such as operational staff, in the design process is often crucial for achieving successful results. Personnel working in the production system on a daily basis generally have a genuine understanding of the system and their knowledge is important to incorporate to the design process. Active participation of stakeholders also simplifies the work to establish and gain acceptance for the proposed changes.
Proficient communication between stakeholders is essential for enhanced user participation. There are essentially three ways to communicate; verbal communication, written communication and the third and final communication path is visual. In the field of product design, the techniques of visual communication are very well developed and frequently used throughout the whole design process. Within the field of work place design, visualisation aids are not widely spread, especially when it comes to the early phases of the work place design process. Visualizations used in the design process of manufacturing systems and work places are often limited to traditional blueprints, different kinds of manufacturing simulations and 3D visualisations to present final design proposals.
As Håkansson et al. [1] states, it is of great importance to create a common mental model of the task at hand and to choose the correct way of communication depending on the type of task. Communication is meant to be used as a tool to create contacts, transmit ideas, influence and develop. It can also be used for making progress visible and provide information necessary to proceed, when progress appears absent [1]. Visualisation increases the opportunity for all parties to actively participate in the development process and is a prerequisite for user-driven processes. A transparent process also

increases the motivation of the employees and the usage of visualisations creates improved affinity among the personnel across the organization [2].

Throughout the design or redesign process of a work place or a production system, from early ideas to the implementation phase, there are several situations when visualisation tools are suitable and can help to improve the quality of the process [3]. Various visualisation techniques perform different functions depending on when and for what purpose they are used during the design process [4]. As an example the planning part of the process can be accelerated by using visualisations, partly because the visualisation technique helps to minimize the risk of unnecessary misunderstandings [5].

Industrial simulations are a common tool to visualise the actual production system. Simulations, however, only provide an abstract view of reality which often makes them hard to understand for anyone other than experts in the field. The usage of simulations can therefore be limited when searching for enhanced user participation. A 3D visualisation of the simulation can help to present the results of the simulation in a way that makes it easier for all stakeholders to be involved and so decisions can be made easier [6]. A method of how to build a virtual factory by integrating discrete event simulation with visualisations in 3D, which makes the simulation much easier to understand and thereby enables user and client participation, is presented by Zhong and Shirinzadeh [7].

A relatively new visualisation method is 3D scanning. By using a combination of CAD and 3D laser scanned as-built data of the current system and facility, photo realistic visualisations of the work place can be made. The method has proven to be a useful tool in the early phases of manufacturing system redesign when it facilitates understanding of the future system [8].

Although most of the research done in the field of visualisation of production system is focused on digital visualisations, simple hand sketches and physical models often have the potential to fill a substantial role in early project phases. To support communication and understanding in cross-functional project teams different kinds of artefacts can be used. An example is a successful study where artefacts such as a layout game board and documents with ideas and requirements were used [9].

Rapidly changing market demands increases the need for efficient design processes with participation from personnel across an organization. Even if the research in the area is still limited most appear to be in agreement when it comes to the benefits of visualisation to ensure a good user and client participation.

If we look at design as a learning process, the noun *prototype* and the verb *prototyping* spurs an interest [10]. A prototype can be interpreted as a representation of a final product, just lacking some minor features. In such a case the intended use of prototypes is to communicate and verify the final design. Only applying prototypes of these kind constraints the communication in the team, since prototypes that appears to be finished decreases the dialogue and feedback in the team [11]. The use of prototyping activities for the sake of learning increases the design thinking, i.e., the dialogue and feedback on ideas. Hence, a wide range of representations ranging from sketches, drawings to different kind of models and animations are suggested to be used as prototypes to mediate user needs and support communication in the team [12]. The application of this kind of low-fidelity prototyping makes it possible to rapidly visualize multiple ideas, and allows reframing failures into opportunities for learning. It also generates perception of forward progress and supports the team's creative capabilities [13].

Sketching is a low-fidelity prototyping method, and the concept of sketching can be stretched further then just using pen on a paper. Any medium could be used; clay, paper, chairs, body postures, 2D- or 3D-modeling software, etc. The ambiguous and unstructured characteristics of sketches results in reinterpretation [14], and sketches are even seen as critical for being able to capture the ambiguity inherent in design activity [15]. The classical engineering tools, i.e. CAE, CAD, data- and protocol analysis etc., are not suited for prototyping activities since they are time consuming and therefore limit iteration. They also lack the ambiguous character of sketching activities; they are precise, fully envisioned and give little room for free interpretation. They are more prototypes than prototyping mediums. This limits the creative freedom since the act of combining and restructuring, that sketches facilitate, is inextricably linked to creativity [16].

In the field of Product Design a wide range of visualisation techniques has been used for a long time to generate and communicate ideas and solutions between users, designers and stakeholders in projects. Being able to think visually is also seen as a necessary skill for the development of innovative ideas [17], and low-fidelity prototyping supports this. By tapping the knowledge and use the experience

from the product design field regarding visualisation techniques and incorporate it into work place design, a more effective development process where all parties can contribute in new ways could be achieved.

2 PEDAGOGIC APPROACH

As stated above, it is identified that using visualisation methods, common within the field of product design, is rare in workplace design. To start to deal with this, the need was analysed and discussed with people from departments at the university working with workplace design and product design as well as with people from the industry working professionally with production development and workplace design. The main issue was the lack of understanding and communication in the early stages of the design process in order to improve efficiency and precision when designing a new workplace. Looking at the field of product design, one uses various kinds of visualisations to overcome this communication barrier as well as for making the design process more efficient and exact. To implement this approach when designing the workplace would improve that design process significantly. The outcome was to create a new course for the fourth-year students where visualisation and communication would be the central parts.

The intended learning outcomes (ILO:s) [18], are to make the student understand how to make use of existing skills, apply this into a new field and to teach the students new ways of visualisation suitable for workplace design. The course content was spread over a number of fields motivating a cross functional teaching team where cognition and communication was covered by Engineering Psychology staff, workplace design by Industrial Work Environment staff and visualisation by Industrial Design staff. The task was to provide a basic understanding of communication and how people perceive and process information in order to make the students understand how and why to choose a suitable way of communication. It was also to develop a knowledge of workplace design including proper terminology, work safety and logistics, and finally to introduce a visualisation thinking approach to the students throughout the design process.

To achieve this, the course was created as a project based course combined with theoretical lectures and assignments parallel to the project. To reach Biggs [19] third level of teaching, how to make the students involve themselves more in the learning activities, the results throughout the course were subjected to peer review where other students evaluated the level of understanding in the communication approach chosen based on previous theoretical tasks in the course.

3 RESULT

The tangible result from this process was a new 7,5 credit course called “Production Visualisation”. The main purpose of the course was to bridge the identified gap when it comes to communication in early stages of workplace layout design by implementing accepted and established ways of visualisation from the product design field in order to make ideas and workplace concepts more tangible during the development of a new workplace design.

To achieve this, the course was designed to contain an assignment of designing a workplace, in this particular course a tyre shop. During the design process, the students had to use different kinds of visualisations in order to communicate their ideas amongst themselves as well as with the teaching staff. Throughout the course, lectures on workplace design and visualisation techniques were held in parallel with the project.

Initially, a task to make a survey of the state-of-the-art on the research field was given. Together with lectures on communication, cognition and mental perception, the students were to write a paper on the field and how the theories were handled in current research on visualisation in workplace design. This gave the students a good theoretical base to start their design task from.

The design task was to design a tyre shop from scratch. Some basic data was given, e.g. what different functions and areas is to be included in the tyre shop, what capacity does the tyre shop need, what storage area is needed, etc. The students were divided into five groups according to the identified and stated function areas; Reception, Workshop, Storage, Tyre hotel and Staff area, and started with identifying the functions and needs for these areas. Visits were made to local tyre shops to get a view of how it works there and to get information from interviews and observations.

Next step was to generate ideas on how to design the different areas, each group concentrated on the area they were given and visualised their ideas with handmade sketches. Figure 1 shows examples of sketches from one function area, the workshop.

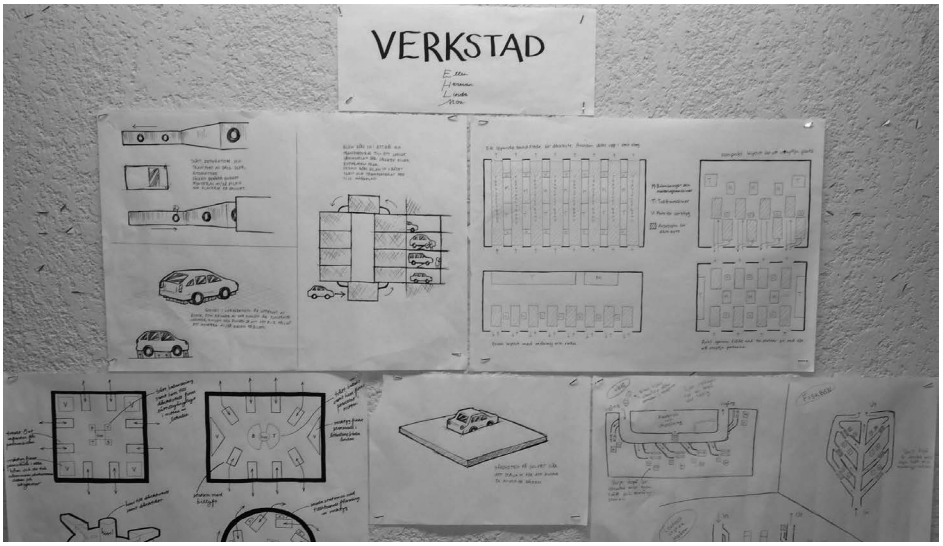

Figure 1. Sketches from Phase 1 ("Verkstad" = Workshop)

The ideas could be on any level, overall schematics as well as detailed design of specific solutions. The aim was to build a wide range of ideas that the whole class could use as inspiration and input for ideas in the later stages of the project, so the focus was more on quantity than quality, and novelty was endorsed. After this phase, the sketches were posted on a wall and the groups were asked to analyse and explain each other's sketches to see if they were understandable and self-explanatory. These sketches then became everyone's property because the course changed from group work to individual work and each student was supposed to design a full layout of the tyre shop.
The next phase was to choose and develop ideas so they could be put together to a full concept. The students were asked to present two distinctly different layouts each and they could be visualised either by hand sketches or with sketches/plans made in the computer. Figure 2 shows an example of such a layout.

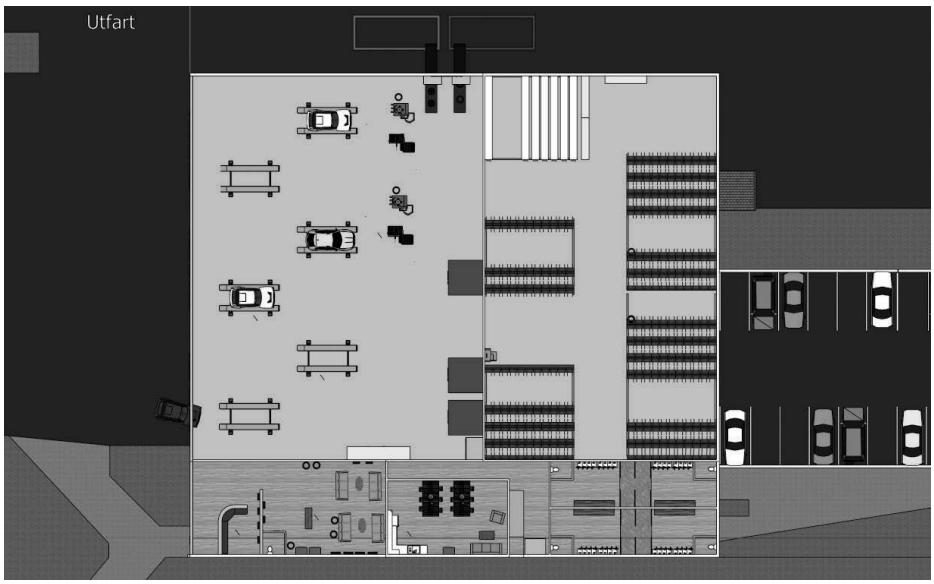

Figure 2. Layout of Tyre Shop

During the presentation of the layouts**,** fellow students as well as the teaching staff were giving feedback on the actual workplace design as well as the type and quality of the chosen forms of visualisation.
The final phase was to choose one of the designs, or a combination of the two, and develop it further in order to be able to present the design concept for an imaginary management group consisting of the

teaching staff. The students could use previous sketches and layouts but were obliged to create a 3D animation using Google SketchUp. Figure 3 shows a screen shot form one of the animations.

Figure 3. Screen shot from 3D animation of workplace design concept.

The choice of Google SketchUp was mainly due to efficiency. The purpose of the course was not to learn new advanced software but making the students apply visualisation techniques in a new way. By using Google SketchUp, the step to start creating 3D models and animations is very short; hence the students can concentrate on workplace design and proper visualisations. A short introductory lecture on Google SketchUp was given to start the students up but the main responsibility for learning how to use the software was with the students.

4 CONCLUSIONS

The key factor when designing this course was the formation of an interdisciplinary team of teachers. Teachers from the departments of Industrial Work Environment, Industrial Design and Engineering Psychology were represented and the course was developed and designed in an interdisciplinary collaboration within the team. The configuration of the team satisfied the need for relevant areas of expertise such as production layout design, user participation, visualisation, communication and perception. A conclusion is that this configuration of the teaching team was necessary to achieve the objectives of the course.

Another conclusion is that it was very stimulating for student creativity to use different kinds of visualisations throughout the development process.

The course is focusing on how different techniques of visualisation can be used in various stages throughout the design process. In autumn 2014 the course was successfully given for the first time and the response from the students was definitely positive. Although there are parts of the course that still can be improved, it is already evident how the course increased the quality in subsequent project-based courses where students, in collaboration with manufacturing companies, used their skills in redesign projects.

5 DISCUSSION

Reflecting on the course it feels like the objectives are fulfilled. The students have learned to use prior skills in a new field, they have learned new ways to communicate visually and they have gotten a deeper theoretical knowledge regarding why and how to communicate when designing a workplace.

As mentioned above, there is already evidence that the students use these visualisation tools in later courses and compared to results from previous years in these later courses, the use of better visualisations improves the results significantly.

The students have been participating actively in the development of the course with feedback from their point of view. This has been very helpful when looking at the extent of the tasks and identifying

parts of the course that could have been designed in a better way. This has also been taken in account when making necessary adjustments for the next course in September.

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