

## SUPPORTING THE TEAMWORK BY NEW MEANS OF THE INFORMATION TECHNOLOGY

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### 1 Abstract

With increasing divulgence of the information technology also possibilities to support the teamwork are arising. In many fields of the product development process an IT-based support is available as for example in the design stage (CAD and PDM). However, the early stages in the product development process still go without the support of the information technology. The topic this paper is to show the causes of that and to show possible solutions.

### 2 Introduction

The complexity of new products requires to process the development tasks within a team. Especially in the product development process competition and time famine make the teamwork - the concurrent engineering - urgently necessary. In many enterprise processes modern information technologies are already used, for example in the design process and also in the sales process. In the early stages of a product development process, where in particular new ideas are created, the information technology is hardly used because the current available technology is not suitable to support a teamwork decisively. The early stages of the development process as a basis for a new product are based on creativity and imaginativeness in the individual person as well as in the team. At the present time the teamwork is based on a paper-based working method which is in a multiple way inadequate, however, in particular with larger groups. Also the documentation of a session is difficult since the integration of the results is complicated due to the unwieldy format of the paper presentations.

### 3 Motivation

Today's team sessions are based on classical methods like mindmapping, gallery method, outlining-method (6-3-5) etc. These methods are rule-based and their success depends very strongly on the composition of a group. Trained teams with personal experience show higher productivity than spontaneously gathered groups. In this case social competence or different levels in the persons hierarchy has a disturbing influence on the effectiveness of the group. Using the above methods requires self-confidence in order to present ideas, to review ideas of the others or to let own ideas to be assessed.

In addition, the use of the methods from the above requires that the contributions must be provided in a hard-copy form which must be clearly and readable. However, in most cases these requirements are not fulfilled. Taking the protocol of a teamsession often becomes very difficult because most of the ideas are created on flipchart papers that are not suitable for a protocol and the flipcharts must be processed afterwards. Additional mistakes arise from that which can noticeable reduce the success of a teamsession. Also very frequently information are needed which are not spontaneously available. This results in delays of the team session.

## 4 Contributions

In order to examine how a new technology can be used in the early stages of the product development process to avoid the above-mentioned difficulties a room was furnished with the currently available technique and practical investigations about his use were carried out. The objective was to find out whether this additional technique is usable or leads to a technical overkill. In a next stage the room will be redesigned and complemented by software tools in order to optimize the teamwork. The technology based conference environment is supposed to offer the following possibilities: presentation from system or laptop; mixedmedia-presentation (for example video, slides, overhead projector, plans, posters, rough paper drafts); simplified taking of the protocol; common sketching possibilities; smaller groups (for a short period of time a smaller formation of groups is possible); providing of external information from databases or out of the internet; integration of external participants by the use of video-conferencing; integration of conventional media and methods; possibility of mixedmode and all-digital methods.

Figure 1 gives an overview of the technology-based conference environment:

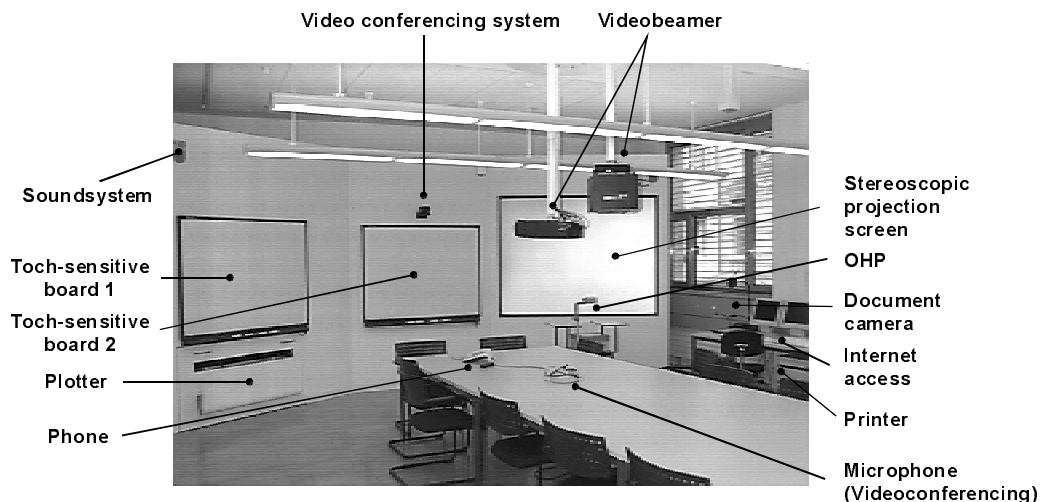


Figure 1. Conference environment

The conference room includes in total three projection screens, two of them are used in connection with a touch-sensitive surface, the so-called SmartBoard. The third projection screen can be used for a stereoscopic projection or video.

The touch-sensitive boards can be used for sketching. The color and the pen position are registered by the computer and the sketches are projected onto the touch-sensitive surface of

the board. Thus, the digitalization of the drawn pictures also fulfills the demand for a simplified recording and archiving because the data can be stored at any time. The touch-sensitive boards represent the common sketching-possibility where the common ideas are created and visualized [4]. A video-conferencing equipment allows the transmitting of picture and sound to a remote station as well as an application sharing. This will allow to communicate and to work collaboratively with additional team members. Thus, it is possible to obtain additional information from further persons and to allow a teamwork via a physical network as well as acquiring spontaneously needed information. For the visualization of existing objects an additional camera is installed. The camera's picture can be projected onto the third projection screen. Small objects and prototypes can be shown to the team as well as conventional overhead slides or pictures. The technology based conference room is completed by the possibility to present videos as well as slides. With the linking of previous media it is possible to realize a mixed-media presentation. An additional connection at the conferencing table gives access to the projectors so that presentations can be directly carried out from a private laptop. The technical installation of the moderation room is completed by the possibility to plot large scale sketches from the touch-sensitive boards as well as the possibility for scaled printouts.

Several test were made with the completely equipped conference room. The scope of these test is to find out the benefits of the new conference room and the way how the persons can work with this new technology. Furthermore it is supposed to be examined, whether previous working methods can be moved in the new moderation environment.

## 5 First Results

The series of experiments were carried out as far as possible with realistic problems. An essential criterion for the successful use of the conference room was the result and the duration of the session. The tests were carried out with students, with members of the institute and with industry partners in order to receive a representative sectional view. It was essential to the carried out series of experiments were made on real existing projects and not on artificial settings. Thus there was a real demand for moderation technique, for presentation technique or for the metaplan technique in order to carry out the team sessions (up to 10 persons) with maximum efficiency. For the teamsession traditional means were available as well as the described new technologies. The scope of the carried out experiments was to find out where the new technology could not be used anymore and the traditional means were used instead.

The working with the new technologies and the different conferencing techniques needs a certain effort. Thus the usage of the moderation room and its technology requires basic knowledge in the information technology in order to take full advantage of the room within a short time.

## 6 Influence on the moderation techniques

In the following fields changes of the moderation technique arose that must be considered by the user:

## 6.1 Writing and sketching

The writing and sketching on touch-sensitive boards distinguishes considerably from that on paper. The recording of the pen position and color by the computer has a latency time which can lead to a confusion while working the first time with this device. Furthermore it has to be considered that the person causes a shadow onto the pressure-sensitive face when a front projection is used. Unlike the writing and sketching on normal paper the line drawn from the pen is only visible as soon as the person is out of the projection way. The shadow caused by the person can be eliminated when a back projection is used together with the touch-sensitive board. This solution is much more expensive and requires more space for the projection system.

Although conventional pens are used for writing and sketching, the time delay, which is inherent to the system, must be considered at the presentation. The delay causes quantization mistakes when the speed of the tip exceeds the maximum value. This will result in an interrupted line although it was drawn continuously. The user must draw consciously slower in order to avoid those mistakes. The tests showed, that the user wasn't disturbed anymore by the effects from the above after a short training stage. After the training phase the writing and sketching on the touch-sensitive boards were possible as fast and simple as on traditional paper. Thus the traditional method and the technology based method are equivalent on this field.

## 6.2 Gallery method

During a discussion the writing and sketching is done on a poster. This poster will be used within the gallery method as an elaborated point when the discussion proceeds. The posters are in the person's field of view so they can refer on them if required. The gallery method allows a parallel visualization of several aspects, which can become important in case of comparative discussions.

In a contrast to the above the usage of a touch-sensitive board allows only a serial visualization of the currently processed poster. A cross-reference is only possible by paging backward. However, this backward paging represents a break in the moderation process which should be avoided as far as possible. Through the serial representation of the processed posters on the touch-sensitive boards it is not possible to compare the individual posters. In the practical usage within the moderation room this deficiency can be counteract in two ways. The usage of two projection screens allows to visualize the current poster as well as one of the posters before. Thus it is possible to generate a new poster and to represent the preceding relevant posters simultaneously. By that the previously described break in the moderation process can be eliminated. Furthermore there is the possibility to print a poster on a A0-plotter and to use this printout for the gallery method.

However, the practical test of these possibilities showed that the use of two touch-sensitive boards as well as the usage of the A0 plotter can only be done by experienced users. Furthermore it has to be considered that no changes or add-ons should be done on the printed posters because these modifications cannot be digitized for a later on usage. However, during the realization of the sessions it becomes clear that two projection screens for the realization of a fluid moderation are sufficient. The additional plotting of the constructed posters during a session was the exception and was not satisfying due to the high time consumption.

### 6.3 Metaplan technique

The metaplan method is used very frequently in workshops in order to create ideas and to find out opinions. This method also can be used for larger amount of session members. Within this method short contributions for a defaulted subject are written onto cards. On a common presentation wall the cards are arranged and combined to an entire unit. This method has the advantage that the participants can create their ideas in a certain anonymity without being disturbed by other influences.

At the present time it is not possible to realize a technical supported metaplan method. There is no technique available to label a card, to digitize it and to displace it onto a common work area from the participant's place. If a metaplan technique is needed for a team session it must be done with the use of conventional means. This causes an interrupt in the technology-based teamwork. The results that are elaborated with the metaplan method are not digitized and must be processed afterwards for further use. Beside the time consumption further mistakes and corruption can arise from that. Therefore the metaplan method is not feasible in the above described environment.

### 6.4 Presentation

Presentations normally consist of two parts. This is the performance of a prepared visualization and the need of supplementary comments. The usage of the touch-sensitive boards offers two possibilities: on the one hand existing PowerPoint-slides can be complemented through additional rough drafts and comments, on the other hand complements can be represented also separately on the second touch-sensitive board.

The test of this possibility brought out very good results. The test persons were mainly able to add complements on the second visualization equipment while the presentation was running on the first visualization equipment. The usage of both touch-sensitive boards did not cause any irritating media alternation but raised the listeners attention since the line of vision could be changed. The presenter must get used to the functionality of the touch-sensitive boards together with a PowerPoint-presentation. It allows to switch to the next slide by touching the surface. In the beginning mistakes occurred during the explanations of the slides combined with the human gesticulation (pointing).

### 6.5 Providing the information

During a session there is the need to provide additional information. The demand for such information arises spontaneous and is not foreseeable. If this information requirement can not be covered by existing materials, an information gap remains that complicates the further process of the session. With the technique installed in the conference room it is possible to retrieve information via the internet or intranet. The carried out test-sessions indicated that many information were already processed by the participants of a session and were provided on servers. Out of this reason the possibility of an information retrieval over a network is very useful. The network access is used in all utilization phases of the conference room: presentations were called up completely over a network and not carried around physically on computers or a missing information is procured during conversation or discussion. The delay which arose from the procuring of the information is marginal in comparison with a delayed session due to missing information. In total the availability of a network is very useful to support an effective teamwork.

## 6.6 Moderation

The technique installed in the conference room enables the presenter to form the moderation of a session more effectively. This is based mainly on a very good visualization of the subjects of interest. This is of interest when a discussion is based on these objects. If the objects are very small only a few members of the discussion can see them while all others have to wait. This causes an unnecessary delay of the discussion until everyone has seen the objects. The problem is eliminated in the conference room by the use of a camera, which takes the picture of the object and visualizes it on the third screen so it can be seen by everyone simultaneously. Tridimensional objects can be turned by moderator and facilitate thus the recognition of specific qualities or functionalities [5]. The sketching on the touch-sensitive board can be visualized via two channels. Thus, the problem of hiding the sketches by the presenter is solved. The second projection screen is not masked and allows the listeners to perceive the visualization and the relevant explanation synchronously.

The available technique enables the presenter to choose a fitting visualization device in order to present almost any information without any spill [2] [3]. However, this will result in new requirement profiles for the presenter, which are totally different from the conventional moderation techniques. An example will be the performed visualization with the use of projectors. This requires a partial or completely darkened room unlike a visualization on posters. Thus, the presenter and his gesticulation becomes less important and an important information channel between the presenter and the team-members is disabled. The classical rules of the presentation technique can only be relatively used in the technology based moderation environment. The usage of the devices is an additional task for the presenter and requires also new rules in the moderation.

The result of the series of experiments was that persons without experience in moderation techniques are unable to handle both, the presentation and the technical equipment. In this case no benefit arises from the new technology. The available technique encourages the presenter to change the media very frequently which has a negative result on the listeners.

## 6.7 Teamwork

Very frequently larger sessions or workshops are splitted up into individual teams. These teams have to process exactly defined subject areas. The teamwork is followed by a presentation for the other workshop members. For the effective realization of the teamwork it is reasonable that the team starts with working materials made available by the plenum.

It is conceivable that every group gets the complete technical setup. However, this is prohibited by the high costs. Due to the missing technical equipment conventional means like blackboards, flipcharts etc. are used instead. Using these conventional devices causes that the technological chain is disturbed. This implies that identical devices must be used for a later presentation of the teamwork in front of the group. From that a break of the technological concatenation results in a deactivation of the technological support. If a further work of the plenum is needed based on the results of the teams the plenum has to use the same means. In order to use the results of the teamwork later on the conventionally generated posters have to be post-processed and digitized. This results in additional work combined with a restructuring of the poster. Since any change can corrupt the poster's contents it is not recommended to make any modifications.

Furthermore a teamwork distinguishes considerably from a presentation. Beside the completely different working methods another essential difference is that the work area is horizontal during a teamwork while it is vertical for a presentation. The available touch-sensitive boards are designed for presentation tasks and thus not suitable for horizontal use. Within a normal interaction, for example during drawing or sketching, the persons frequently touch the sensitive surface at several places. Placing the hand on the pad during the writing or sketching will cause digitalization errors. This problem was recognized very fast by the tested persons. However, the above described mistake occurred again and again. The reason for this is that the required single-point input for the touch-sensitive board is not corresponding to the natural movement of the human being. The unnatural way the write or to sketch on a horizontal surface results in a cramp and in fast exhaustion. Combined with that is a clear reduction of the efficiency of a group [1]. Another difference between a teamwork and a presentation is that the teamwork uses other techniques than a presentation, for example it is not moderated. Thus, it is possible that several members of a team can draw simultaneously. However, a synchronous recording of several pen positions is not supported by the technology of the touch-sensitive boards. Therefore the touch-sensitive boards cannot be used for such a teamwork.

In conclusion the available technology does not support the work of subgroups very well. However, the available technology basically supports the presentation but not the creative generation of ideas.

## 6.8 Taking a protocol

To guarantee the success of a carried out session it is necessary that a protocol is taken. Taking the protocol of a conventional session is difficult, since the elaborated documents are not suitable to be taken into a protocol without any modification. Large scale documents like posters have to be reformatted or post-processed in order to make them suitable for the protocol. Very frequently important context information is lost and a later reworking of a session becomes complicated. In addition the preparation of such posters is time-consuming and cost-intensive. In part important posters are linked into a protocol as a photograph. In order to keep the document size small for an electronic forwarding the pictures are embedded with low resolution which complicates the later on use.

The carried out series of experiments showed that the possibility of the immediate printout of the posters is regarded as very useful. These printouts can be full-scale by the use of a plotter or they can be scaled down in order to realize smaller formats for a printer. In part the digital data which were created in the plenum could be taken over directly into the protocol. An essential advantage of the digitizing by the touch-sensitive boards consists in archiving and reworking. All written or sketched inputs are in a digital form and can be distributed for example to the team members as a handout. The digitized data can be used in future sessions, either with the functionality of the touch-sensitive board itself or with a bitmap processing program. All the required tasks could be done by the tested persons very easily and result in a higher effectiveness of the carried out sessions.

## 7 Conclusions

The different situations of a teamwork were examined, both the work in the plenum as well as the work in smaller teams. The carried out investigations made clear that the technology of the conference room cannot be used completely without further knowledge on the system.

Although the intuitive writing or sketching on the touch-sensitive boards is possible after a short training phase the further use of these elaborations as well as the usage of the peripheral units only can be done by a trained presenter.

The technology-based conference room does not support all conventional working methods. Thus, in many cases the conventional methods are still needed. Using such a conventional method causes a break of the technological chain. In particular in the presentation technique, in the elaboration of common posters and in taking the minutes the new technology is very helpful. On the other hand other techniques as for example the metaplan technique or the teamwork cannot be supported very well by the new technology. The currently available components only can be used in particular fields. However, they do not offer yet a comprehensive solution for the realization of a complete meeting.

## 8 Future work

Future work will aim at eliminating the recognized problems. This will be in particular the realization metaplan technique as well as the realization of an teamwork supported by new information technologies. A continuous technological chain over an entire teamsession is supposed to be achieved. On the one hand this can be done by better software- and hardware and also in the networking of existing components. On the other hand the construction of new interaction devices and procedures have to be realized. In order to keep on optimizing the moderation technique the writing and sketching on the two touch-sensitive boards must be exchanged between the two projection screens as desired. This will realized by extending the currently used software.

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### References

- [1] Ernesto Arias, Hal Eden, Gerhard Fischer, Andrew Gorman, Eric Scharff; „Creating Shared Understanding through Collaborative Design“; University of Colorado, Boulder; CHI-Proceedings
- [2] Thomas P. Moran, Patrick Chiu, William van Melle, Gordon Kurtenbach; „Implicit Structures for Pen-Based Systems Within a Freeform Interaction Paradigm“; Proceedings of CHI 1995
- [3] Jason A. Brotherton, Janak R. Bhalodia, Gregory D. Abowd; „Automated Capture, Integration, and Visualization of Multiple Media Streams“; Proceedings IEEE 1998
- [4] Peter Troxler, Kristina Lauche, Kyeni Mbiti; „The Use of Interactive Boards for Collective Design Processes“; International Design Conference, May 23.-26, 2000
- [5] Orfeo Niedermann; „Nutzenanalyse des Einsatzes der Virtual Reality Technologie in der Failure Mode and Effect Analysis“; ETH Internal Research Report 1999