Methods and tools for evaluation of usability in buildings

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Abstract

From our perspective, buildings are means of production, and should be evaluated based on their potential to support organizational performance and achievement of goals. This paper presents examples of methods and tools for assessing usability of buildings used in different research projects at SINTEF and NTNU during the last 5 years. The purpose of this overview is to describe and discuss the different methods and reflect on their relevance for different aspects of usability. The paper will discuss different aspects which are important for usability evaluation, such as purpose of evaluation, user perspectives, parameters for evaluation, methods as participatory instruments, scales and measurement, as well as levels of evaluation. The paper will present and discuss examples of methods used for research and development purposes from the projects "Usability, case Nylåna, Norway", "The Knowledge Workplace", and "Children and their use of spaces".

This paper's objective is to contribute to further development of theories and methods for evaluating Usability, developed within the CIB workgroup 111, Usability of workplaces.

Key-words: Usability, Buildings in use, Evaluation methods

INTRODUCTION

Buildings are built for a purpose: for education, for work, to live in, etc. Depending on how well they serve their purpose, buildings contribute to efficiency, effectiveness, and satisfaction for their occupants. Even so, most occupants, owners, designers, and constructors never perform evaluations of how well their buildings perform. According to CIB (2005) conventional approaches to building performance have focused on technical, functional, and operational aspects of their use. Only recently, building performance of buildings in use has been studied. For organizations, a large proportion of cost is related to facilities. Thus, the cost/benefit ratio of facilities should be of great importance to companies. Any potential benefit for enhanced performance due to more efficient and effective buildings, which enhances different user groups' satisfaction, will improve the cost/benefit ratio.

The concept of usability was first developed in the 1950s, for ICT and software development (Leaman, 2000). Usability means the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (ISO 9241-11). Usability of buildings is a much younger subject, as the work of applying the Usability concepts to buildings has only been going on for under a decade. This means that both the theoretical and the methodological aspects of studying buildings in use with usability in mind are still developing. Theories, concepts, and methods are tested and discussed, and relations to other building research subjects, such as design theory and Post Occupancy Evaluation, are analyzed. This paper is one input to that debate, as we aim at reflection on different existing methods, and discussion of further development of methods that can give better understanding and knowledge about usability.

When evaluating the usability of buildings, we aim to evaluate the relation between building and people/organization. The users' actions are unpredictable, and there is a long list of user

types and groups. Users interpret and interact with the building with all their senses, their cultural and social baggage, and often (at least in parts) unconsciously. Buildings last for a long time, and will have interactions with many user groups at different moments in time (Blakstad, 2001). This means that evaluation of the relation between people and building is challenging. Working with usability, we should not only focus on the individual level, but also look at the impact of the building in the organizational context. How does the building support the work that is performed in the workplace? Will it enhance learning? Or, do buildings have an impact on organizational goals at all?

The definition of usability stresses that usability depends on how a product can be used by specified users to achieve specified goals. According to ongoing discussions in W111, usability can be seen as a process; it is contextual and is developed within the relationship between an organization and its building(s). In his progress report on the work of W111 in Paris February 2008, Keith Alexander states that while functionality can be evaluated on the product (building), usability can not be evaluated on the product - only in the situation of use of the product that depends on users' values in culture, context, time, and situation. He states that usability has partly to do with the properties of the product, but even more with the process of design and use. This is in line with recent theoretical works on Usability, e.g. Fenker (2008) who argues that usability is a process that can only be understood as a social construction. Granath and Alexander (2008) propose to replace the rationalist perspective that argues that usability lies in the properties of the product, with the pragmatic view that usability is connected to user *experience* of buildings.

In our work at SINTEF and NTNU we have focused on buildings as means of production, and their potential to support organizational performance and achievement of goals. A traditional view of production is that the main resources are capital, labour, and production technology. Entering the "knowledge society", information was added to the list of resources for production. In a series of CRE reports Joroff et al (1993) proposed that real estate is the fifth resource for production. In line with this we developed a KUNNE Knowledgeworkplace-model, where workplace performance is related to people (labour), ICT, and space (Gjersvik & Blakstad, 2004). The perspective of workplace, facilities, building, and real estate as means of production also underlies this paper. Usability is, as stressed in the definition, related to achieving organizational goals. In line with this, the effect of the building (effectiveness) is related to productivity and achievement of goals. In kindergartens, good care, learning, and social experience are important goals. In an office building, related to offshore production, a cost effective, safe, and secure production of oil and gas is the goal. Our main perspective is on Usability's relation to organizational goals and output.
This means that methods for evaluation of usability will have to explore the user experience of buildings, the relationship between buildings and multiple users, the process and time, as well as the culture, work style, and goals of the organization. This also means that the concept of usability is both individual and subjective, as well as organizational and collective.

Our discussion will be based on 3 Norwegian research projects undertaken by NTNU and SINTEF. The first case is Nylåna, University College Campus in Levanger, Norway, being on of the first cases developed by CIB Task Group 51, Usability of Workplaces. The second case is the Knowledge Workplace, KWP, a research and development project financed by the Norwegian research council and several large building users and owners. The third case is "Children and their use of spaces" ("Barn og rom").

EVALUATION OF USABILITY

In this part of the paper we will discuss some factors important for evaluation of usability. This will later be discussed in relation to actual experiences with different methods and tools.

Purpose of evaluation

In our work with these cases, we have identified at least three purposes for evaluation of usability. First as feedback to planners, owners, users, and Facilities Managers in order to improve usability, both within the given context and as learning for future projects. Second, we have aimed at evaluating usability in order to contribute to general knowledge and research. And third, an understanding of user needs and usability is developed as input to a briefing or design process.

In Building Evaluation Techniques, Baird et al. (1996) presents a framework for understanding the motive for Building evaluation and the evaluation practical or theoretical nature. We have developed this in two dimensions:

- Motive for evaluation internal vs. external
  - *Internal*, attention to decision making and place learning
  - *External*, the motive is outside the user organization, the goal is knowledge
- Nature of study, practice vs. theory
  - *Focused on practice*, empirical, experiential knowledge, close to practice
  - *Theoretical and scientific*, based on theories and empirical testing, traditional scientific lines, rigorous methods, systematic research, test reliability and validity.

Baird also points at the importance of a dialogical process of moving back and forth between theory and practice.

Both nature and motive of study will be important for which methods and criteria one chooses to focus on in any particular study. Methods and criteria are thus both depending on the nature of study and the context, as well as on objectives and actors' points of view.

Subject of evaluation

As discussed in the introduction, evaluation of usability is related to the user experience and organizational goals. From the definition of Usability, effectiveness, efficiency, and satisfaction are the main factors. According to our perspective on buildings as means to achieve organizational goals, effectiveness is the main purpose. Efficiency and user satisfaction can be seen as tools to enhance effectiveness.

Level of evaluation

One explanation on the lack of evaluations of building in use can be the fact that evaluations can be quite time and cost expensive to carry out. In Preiser et al (1988) and Preiser (2003), three levels of investigation are described for Post Occupancy evaluation:

- Indicative: Provides an indication of failures and successes of a building. Requires a limited amount of resources
- Investigative: Based on indications from level 1. More topics, detail, and reliability. More time consuming, and requires more competence and more sophisticated methods. Evaluation criteria more objectively and explicitly stated. Benchmarks with state of the art literature and facilities.
- Diagnostic: Comprehensive and in-depth investigation. Multi-method strategy. Research approach. Large scale projects, many variables.

In the case of Nylåna, Adrian Leaman states that good usability in buildings depends on robust performance on basic factors like comfort and space provision. If the basics are in place, then other factors tend to follow (Hansen et al, 2005). Follow this perspective; it will be important to define indicators that will give the basic information on usability to improve the building's ability to meet the user's needs.

The user perspective
Most buildings have multiple user groups and different user roles, e.g. pupils/ teachers, staff / customers, patients / medical professionals. In any study of usability, a documentation of the different users and their goals and practice will be essential. In studies of usability it is important to differentiate between users, actors and stakeholders such as end users (individuals, teams, departments, etc), Facility Managers, building owners, visitors, and the society at large.

Different stakeholders and organizational levels have different perspectives considering usability of buildings (Fenker, 2004). In the Nylåna case (Hansen, 2006), the study shows that there are different opinions on the usability issues reflecting different views of the students, teachers, administration, and FM staff. What appears as usable and efficient from a student's point of view does not necessary mean the same for the staff. The study also concludes that cultural aspects and background play an important role in the different users' evaluation of usability in that case. Any evaluation of usability will have to discuss which user groups are targeted, and output must be related to the perspective of the actual user groups and their contribution to achievement of organizational goals.

Methods as boundary objects
In several of our cases, we have used participatory methods. This means that the users are engaged in a development process, constructing understanding and reflection on their own work practice and their relation to the building. Using such participatory methods and processes, the process and its working documents may act as boundary objects. According to Kjølle et al. (2005), many of the processes and documents used in briefing are really boundary objects, used to construct a common foundation and understanding onto which different stakeholders with different languages, expertise and knowledge can actively explore the user's experiences and needs. From the participatory methods used in our work, we have learned that it is very useful to engage different user groups collectively in order to construct a better understanding of their experience with usability within the actual context.

Scales and measurement
The question of what usability means and how we can understand the concept is essential in the design for exploring usability. This is directly related to the question of indicators and how we can measure usability in a certain building, for a particular organization, at a specific time. As discussed above, evaluation of Usability involves many factors, and many of them are difficult to quantify. So far in our research, most of the research has been explorative, using qualitative methods, often case studies, as research strategies. For more descriptive and causal studies we will need to develop methods that give us quantitative data and defined indicators that may allow us to benchmark between multiple cases. So far, only the surveys have produced this kind of data. At this stage in our research, most emphasis has been on exploring usability factors and testing methods. This is an important first step into developing more robust research designs. It might however be that we discover that the nature of our research problem, to discover how buildings support organizational objectives, is hard to explore with descriptive and casual studies due to the dependency on the different contexts and many interdependent variables.

Ongoing discussions in our research projects suggest that there are both context dependent and generic parameters and factors in evaluation of Usability. To our knowledge, there has been no research to determine the relation between context dependent and generic factors. Further research will have to investigate this, both on the organizational and the individual level. For now, these issues should be discussed for each case.

METHODS AND TOOLS – EXPERIENCES FROM 3 RESEARCH PROJECTS

In this part of the paper we will describe and discuss some of the methods and tools used in the three cases.

Document analysis
In order to establish context and situation of the cases, all three projects started out with document analysis. Such analysis includes briefs and architectural descriptions and project presentations, minutes, drawings, articles, annual reviews and company presentations, other case-studies within same context, reports on work environment and operation, etc. From our cases, we have seen that this is a relatively fast and efficient way to familiarize us with the case and to understand the background and premises for original project and the present situation.

In the case of Nylåna, the document analysis gave an important input to the comparative analysis of the program requirements, the changes during the project development and the use of the building after completion. Together with interviews, the analysis identified imbalance between physical concepts and pedagogic principles (Hansen et al., 2006).

Interviews
Interviews were used in all three projects. Together with document analysis, interviews with key informants have been used to create the initial understanding of context and situation in both Nylåna and Barn og rom. Interviews are also used in all three cases to explore users' experiences with the building in use and with working in the organization. In the Nylåna case, individual interviews focused on user experiences with the relationship between users' needs and what the building actually offered. Group interviews (semi-structured) have been an important method in the KWP project where they have been used for several purposes:
- To learn to know new companies and departments and to understand their use of space and existing work practice, often prior to major workplace changes
- To understand the use of new offices (½– 1½ years since moving in), use of space and new work practice
- To evaluate processes (moving into new workplaces, user involvement, and design process)
- As preparation for user surveys

In the Barn og rom case, parents, employees, and building owners were interviewed. In addition to this, we used group interviews with children. The children where taken on a "walk-through" and videotaped. During the interview, they spoke of their impressions and experiences, and acted out many of the different possibilities of use in the building.

Interviews have been a powerful and important method in all three projects. In these cases interviews have proved to be well suited for exploring complex situations and relations, such

as usability. With group interviews we have also seen that the effect of talking together, focusing on usability and the organisation and its relation to the building, is important as a participatory tool as well as for evaluation.

Another important lesson from all three projects is that semi-structured and open interviews on a complex issue like usability requires a skilled and reflective interviewer. This is especially the case with children, where this is a special skill. Another important aspect is that we have seen that we are much better equipped to analyse and extract meaning for the interviews within a multi-professional team. In the case of Barn og Rom, this was essential to be able to analyse the data from the interviews.

Obviously, the findings from interviews will depend on the selection of interviewees and which questions are being asked. This highlights the importance of a more standardized framework and a vocabulary that support evaluation on usability.

Walk-through
In the different case study reports in CIB W111, walk-throughs are the most commonly used methods for evaluation of usability. Walk-through is a qualitative, but systematic, way of assessing different aspects of building by using different stakeholders as informants. The Walk-through is not really one method, but a common term for several different techniques, in which informants are taken on a "tour" of the building, assessing different qualities and shortcomings of different parts of the building.

In the Barn og rom case, the walk-through worked as a method to gain fast input on three aspects: Positive/negative impressions and experiences, and suggestions for improvement of different parts of the buildings. The results were analyzed by looking at input from three different user groups: employees, parents, and researchers. The findings from the walk-through were later used as a starting point for interviews, observations, and analysis of video material. As mentioned before, the children were also taken on a walk-through and interviewed. The session was videotaped, and served as important material as documentation of in-situ interviews with children.

In the Nylåna case, we had representatives from teachers, administration staff, students, and FM staff. Together, their knowledge covered a wide range from technical aspects to accessibility, functionality, and user satisfaction. The participants' definitions of key-factors essential for the building's suitability reflected their work tasks and experiences with the building.

In both projects, we have seen that the walk-through is a simple and rapid way of getting the first overview and indications of the usability of the building. The results from the walk-through and the quality of the evaluation will depend on who is participating, the preparations, the route for the walk-through, and the focus of the evaluation. One example of this is that in the Nylåna case, one of the participants had a physical handicap that helped us understand aspects of accessibility. Similarly, greater detail came from the staff from the music and nursing departments in the group.

Surveys, questionnaires
In the Nylåna case, we attempted to use a well-tested and developed Post Occupancy Evaluation, Building use studies (Leaman & Bordass, 2001). The Nylåna case came out very high on the benchmarks with other UK buildings, but the survey failed to detect the lack of

special types of space in the building, as well as the gap between organizational objectives and new ways of teaching, and the building. These aspects were uncovered using other methods (interviews and walk-through).

In the Nylåna case, we found that the survey gave some hints about the effectiveness of the building, but it is not specific enough to give detailed information on efficiency. This may reflect the difference in culture and focus on different aspect of usability between the Scandinavian countries and the UK.

The question of what usability means, and how we can understand the concept, is essential in the design of a questionnaire exploring usability. This is directly related to the question of indicators and how we can measure usability in a certain building, for a particular organisation, at a specific time. From this case study, we see a need for developing the questionnaire to give more answers regarding the efficiency and effectiveness of the building. Topics like way of working, need for space need for technology, flexibility, and adaptability would be more central in this survey.

Buildings in Use focuses on indoor climate and comfort, but not on issues related to usability as such. In the KWP case, the survey focused on a wider range of criteria. A web-based end-user survey based on 5 standard modules was developed, each with several questions (Hatling & Molberg, 2007):

- Needs, demand. How well the workplace satisfies end–users, when it comes to individual and collective work, knowledge production and sharing, concentration
- Satisfaction and work environment
- Use of space and place
- Physical work environment, air, temperature, noise, space for storage, furniture and equipment aesthetic
- The process, moving in and out of new offices, participation, adaption to workers' needs and preferences, information, etc.

In addition to the standard questions, each company is given the possibility to add other questions that are relevant to their situation. 1100 respondents have answered the questionnaire so far, and the response rate is between 50-80 %. The survey has been used in approx. 20 different offices (departments) in 6 different companies, and it is thus possible to benchmark results between both departments within one company and between different companies.

The experience from KWP is that if the right criteria are developed, user surveys may be a beneficial tool for evaluation of certain aspects of usability. User surveys will also give possibilities for standardized questions and scales, which can be applied for benchmarks. The experiences from both Nylåna and KWP suggest that surveys should be a part of a multi-method strategy in order to uncover issues not detected in the survey.

Participatory methods, workshops, narratives and pictures
As mentioned earlier, Usability methods can be used both in order to analyse and evaluate existing building – user relationships, as well as for design and development of new projects. In the KWP project, the main focus has been on the latter, and since our objective has been related to organizational learning and development, several participatory methods and tools have been developed and tested. Among the methods are workshops with users and managers, describing business aims and objectives as well as discussing future work and facilities. In the KWP project, we have focused on participatory processes, in order to articulate and develop

aims and objectives and to make them operational for use in design. Tools in such workshops can be metaphors, pictures, etc. Evaluation of usability must be related to organizational objectives. Thus, reflection on objectives and relationship between work practice, use, and building, is important also for evaluation. Workshops, as well as other participatory methods, can be used as boundary objects in order to define and develop understanding of objectives and work practice, and as facilitators for the users' reflections over their use of space and place. Other participatory methods used in the KWP project are narratives (learning stories), and pictures taken by the users to illustrate their relation to space.

Documentation of use of space: observation, videotape, and photographs
Both in KWP and in Barn og rom, we used observation, and researchers' documented actual use, activities, and movement in the building. In the Barn og rom case, the observation was supported by videotape and pictures of the children using the space for different activities. The recordings focused on documenting children's use of space, interaction between children, and interaction between children and adults. The observations were analyzed by a multidisciplinary research group. Analyzing video observations, was a necessity in ways of analysing informants which to a scant degree were able to express their needs, and describe their preferences in words. Photos of children's activities and use of space were taken by one of the researchers. Matched with a description of the situation in which they were taken, the photos were a powerful tool for the research team in analyzing children's preferences in their use of space.

Analyses of space and movements in space
In the KWP project, analysis of space and spatial relations has been developed in relation to planning and design of new facilities. The same methods have not so far been used to evaluate workplaces in use. Some of the knowledge from the development projects should, however, be useful also for evaluation:
- Identification of functions with different characteristics, e.g. activity, noise, concentration, movement, etc.
- Analyses of the relations between such functions: zoning, etc.
- A layered design approach to floor-plan layouts in order to improve flexibility, where the main structures, the "footprint", represent structures and functions that are not expected to change as rapidly as other functions, such as the workdesks, etc.

In the Barn og rom project, both functional analysis of the floor-plan and Space syntax analysis (Hillier et al., 1976) were conducted. The Space syntax studies analysed integration, control, and depth of the special structures in different kindergartens. The Space syntax analysis was compared with the observation of movements of children and adults in space. Movements were registered continuously and drawn into floor-plans to create a "map of movement" through the building. The analysis of movement compared with the Space syntax analysis, showed which part of the kindergarten that was the most central and actively used. Compared with findings from observations, the analysis of the floor plan gave interesting findings. The kindergarten where the most integrated room coincided with their natural meeting place functioned a lot better than the kindergarten where the most integrated room was a narrow, non-furnished room.

Mapping movement, combined with Space analysis, is a powerful tool to identify actual use over time. However, there is a need to develop a useful and efficient tool for systematic gathering and analyzing mapping of movements, as observation requires much time and resources.

User patterns, Time/activity/space studies
In the KWP project, two different systems for analysis of use of space and time have been developed.

- Self-reported use of time. Selected users are given the task of reporting the start and end of every activity (for typically 1 week). They will record the actual time (hh:mm), if they are alone or together with another person, and a short description of the activity. The results are later punched into a worksheet, and activities registered as standardized activities, such as: formal meetings with colleagues, social meetings with colleagues, individual work in from of computer, etc (Paulsen & Hatling, 2008).
- Registration of presence in facilities. The number of people presents in cellular offices, office landscapes, and different meeting rooms, were registered into handheld PDAs every half hour during 2 weeks. Each room was given a code, and the different departments were analysed and compared based on their actual presence within the facilities.

Both registrations gave valuable data about present use of the buildings, and were used as input to design of new facilities. Their value for Usability as such seemed to be limited, as effectiveness and user experience were not assessed.

Work pattern, culture analysis and work styles
In relation to the KWP project, two short surveys have been developed in order to access the nature of work and the work culture in the company (or individual departments). In the method which is used to place the user organisation in relation to it work culture, a survey with 20 questions is developed (Paulsen & Hatling, 2007). Another method used in the KWP project, is the use of semantic differentials in order to rate qualities and challenges in the present workplace.

Both methods have proven to be valuable as boundary objects in discussions about present and future use of workspace. It has not so far been used a tool for evaluation, but it might be used as such in a participatory process.

Combination of methods
Usability is in many ways a "wicked problem" (Granath & Alexander, 2008). Wicked problems have no definitive formulation of solutions, and they are open to multiple interpretations (Rittel & Webber, 1973). Exploring "wicked problems" will usually require multi-method strategies. In all three cases we have used different methods – and the results from each method are discussed in relation to each other. In Barn og rom, we used the research group as a panel in order to discuss results and interpret video and pictures. The research group consisted of different professionals, and the different viewpoints and competences were vital for developing the final results. In the KWP project, user groups are used to discuss relevance, interpretation, and meaning of findings, in much the same way.

CONCLUSIONS

The purpose of this paper is to discuss important aspects of evaluation of usability, and to present experiences from some of the methods and tools we have used during the last years. Our most important finding is that though we have documented a wide variety of methods, very few of them aim directly at evaluation of usability, related to organizational objectives

and effectiveness. In most cases, the assessments from users are more based on their personal experience than on the fulfillment of organizational objectives. We find a number of different methods for evaluation of efficiency both related to buildings and to organizations. We have quite a few methods for evaluation of effectiveness and satisfaction, but effectiveness is more difficult to assess. Related to our perspective on buildings as means of production, effectiveness will be the most important. This means that we still need to develop criteria, measurement scales and methods to deal with effectiveness. Of the methods we have used so far, interviews, participatory methods, and walk-throughs are methods that will be well suited for further development in order to evaluate effectiveness, but we will also need to develop criteria that can be used in quantitative studies such as questionnaires.

Usability is complex, but in studies of usability we will have to narrow down the number of parameters and criteria. In our 3 case projects we have seen that the complex nature of Usability highlights the importance of triangulation of methods (multi-method strategies) and research teams with different backgrounds and skills. We have described usability as context dependent, and related to user experiences and social relations between users and facilities. This means that we so far have not been able to pinpoint any generally accepted key performance indicators, or even commonly accepted criteria and benchmarks for Usability. This will be addressed in forthcoming projects at NTNU / SINTEF, where we are looking for methods to define usability of several objects within a portfolio in more resource-efficient ways.

In our studies, we have studied the relation between organizations and physical environment. We have seen that other parameters than physical environment are as important for Usability as buildings and space. We have also seen that physical environments may be important in order to fulfill organizational goals. In all three case-projects we have seen that the key to good usability is related to good relations between the people and the building and clear organizational strategies for work and use of buildings. This supports the proposition that usability cannot be evaluated by assessing only physical parameters, and will be important when we continue development of methods for evaluation.

In further research, we aim to explore how buildings support organizational goals using output from descriptive methods as input to participatory processes. Developing tools and instruments for the continuous dialogue between the building supply side and the organizational demand side, we aim to meet the need for tools to enhance long time effective facilities.

References
Alexander, K., & Granath, J. Å. (2008) **A theoretical reflection on the practice of designing for usability.** Unpublished paper CIB W111.

Amundsen, H. et. al. (2007) **Barn og rom, refleksjoner over barns opplevelse av rom.** Trondheim Norway. SINTEF Byggforsk.

Baird et al. (1996) **Building Evaluation Techniques**. McGraw-Hill.

Blakstad, S. H. (2001) **A Strategic Approach to Adaptability in Office Buildings**. PhD thesis, Norwegian University of Science and Technology.

CIB (2005) **Usability of workplaces, report on case studies**. Rotterdam, Netherlands, International Council for Research and Innovation in Building and Construction.

Fenker, M. (2008) **Towards a theoretical framework for usability of buildings**. Unpublished paper. CIB W111.

Gjersvik, R., & Blakstad, S. H. (2004) Designing Knowledge Workspace. Archetypes of Professional service Work as a Tool for change. In: Carlsen, A., Klev, R., & von Krogh, G. **Living Knowledge**. New York, Palgrave Macmillan, pages 140 – 163.

Gjersvik, R., & Blakstad, S. H. (2004) Towards Typologies of Knowledge Work and Workplaces. In **Facilities Management. Innovation and performance**, red. Alexander et al. , London, SPON press.

Hansen, G. & Knudsen, W.(2003) **Usability – A matter of perspective**. Paper. Changing user demands on buildings. ISBN 82-7551-031-7. CiB W70 Trondheim International Symposium. Trondheim, Norway 12. – 14. June 2006

Hansen, G., Haugen, T. et. al.(2005) **Usability of workplaces, Nord-Trøndelag University College Nylåna, Røstad. ISBN 82-14-03428-0.** Trondheim, Norway. SINTEF Teknologi og samfunn and NTNU.

Hatling, M., & Molberg, M. (2007) **KUNNE funn om åpne arbeidsplassløsninger.** Unpublished article.

Joroff, M., Louargand, M., & Lambert, S. (1993) **Strategic Management of the Fifth Resource**. Corporate Real Estate. IDRC.

Kjølle, K. H., Blakstad, S. H., & Haugen, T. (2005) Boundary objects for design of knowledge workplaces. In: **Proceedings of the CIB W096 Architectural Management**. Denmark 2005.

Leaman, A. (2000) Usability of buildings: the Cinderella subject. In **Building Research and Information,** Vol. 28 (4), pages 296-300.

Leaman, A, & Bordass, B. (2001) Assessing building performance in use: the Probe occupant surveys and their implications. In **Building Research & Information**, Volume 29, Issue 2 March 2001 , pages 129 – 143.

Lindahl, G., & Granath, J. Å. (2008) **Culture and Usability**. Unpublished paper. CIB W111.

Molberg, M. (2007) **KUNNE Karakter. KUNNE metodebatteri**. Trondheim, Norway, SINTEF Teknologi og samfunn. Available at <www.kunne.no>.

Hatling, M., & Molberg, M. (2007) **KUNNE funn om åpne arbeidsplassløsninger**. SINTEF Teknologi og samfunn. Unpublished article.

Hillier, B., Leaman, A., Stansall, P. & Bedford, M. (1976) Space syntax. In **Environment and Planning,** B 3(2), pages 147 – 185.

Paulsen, T. (2007) **KUNNE Praksis. KUNNE metodebatteri.** SINTEF Teknologi og samfunn. Available at <www.kunne.no>.

Paulsen, T. & Hatling, M. (2007) **KUNNE Kultur – de konkurrerende verdier. KUNNE metodebatteri**. SINTEF Teknologi og samfunn. Available at <www.kunne.no>.

Preiser, W. F. E., Rabinowitz, H. Z. & White, E. T. (1987) **Post Occupancy Evaluation,** Van Nostrand Reinhold company.

Preiser, W.F.E. (2003) **Improving Building Performance**. Washington DC
 US, NCARB Monograph Series.