Integration of Sustainable Approaches in the Building Design Process

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1 Abstract

Sustainable approaches in the choice of building components require attentive control of the building design and complex analyses of the behavior of chosen components and their ecological balance. One strategy to support sustainable approaches is the technique of integrated planing. Integrated planing comprises both, horizontal (interdisciplinary teams) and vertical (building life cycle oriented) integration. Its realization requires the ability to view a building under different aspects (e.g. views of domain experts) and at different stages over time (preliminary design, design, construction, operation, demolition). These different views can only be considered at once, if different approaches in various areas such as computer aided design (CAD), modeling (PDM), and cooperation (CORBA) are integrated into one working environment.

Over the last decade, the Institut für Industrielle Bauproduktion (ifib), University of Karlsruhe, Germany and the Institut für Kernenergetik und Energiesysteme (IKE), University of Stuttgart (Germany), have investigated various tools and techniques, supporting the implementation of these approaches. Several research projects were subject to experiments in this context.

2 Introduction

Drastic changes in technology and economy currently impact common working structures. Moreover a fundamental move of western societies from industrial societies, service oriented societies to information societies can be observed. Like other industries, the building construction business is also exposed to the challenge of those fundamental changes, not only regarding an always growing stock of information on building components and materials to be used, but also because of new methods of collaboration of all participants in the design process.

Integrating sustainable approaches into the building design process requires a high degree of transparency on many related subjects, usually conducted by separate participants. However, common design teams are usually overwhelmed by the degree of communication and collaboration required to integrate e.g. knowledge of sustainable approaches into the design process. Because most buildings are designed and build as „one of a kind", optimization of the design process, which is generic in nature, can not be reached by implementing deterministic solution strategies. Many components have to be developed and, moreover, integrated into a single design solution.

Methods of integral planning have been developed under this prospect but never emerged as dominating solution strategies, because of their complexity and high demand on communication action, required by all groups or individuals participating in the design process.

To develop an environment that supports distributed work, real collaboration of all design participants and integration of domain experts, not necessarily limited to the field of building construction, is therefore preliminary condition to any further development in the area of integrated planning.

Utilizing advanced technology, a twofold approach in research and education, undertaken at the Institut fü Industrielle Bauproduktion (ifib), University of Karlsruhe, Germany and the Institut fü Kernenergetik und Energiesysteme (IKE), University of Stuttgart (Germany), is the basis of efforts towards the integration of sustainable approaches in the building design process. The development of a platform, supporting distributed cooperative work within the context of several research projects (e.g. INTESOL, OPTIMA, RENARCH etc.) and efforts to convey new methods of collaboration to students within lectures, seminars and design classes, are the most promising means to transfer theoretical goals into practice.

The focus of this paper is to present the current state of work and to report on experiences gathered during an interdisciplinary experiment addressing integrated planing strategies. The experiment took place at ifib and IKE. A group of students had to design future office spaces, based on expectable technological, methodological and social changes over the coming years. Using currently available CAD tools the students had to present their documents on the Internet, employing WWW technologies.

3 Methodological Approach

To reach a high level of integration in the planning process, each group or individual participating needs to collaborate effectively in a goal oriented manner. Only a goal oriented view, essentially holistic in nature, guarantees the successful completion of all tasks involved in a project. This becomes more clear if we look at the design process as an iterative process, composed of three stages: analysis, synthesis, and evaluation [1].

In traditional planning environments, the available band-width among human beings is insufficient for team members to share the same knowledge [2]. However, sharing the same knowledge is a prerequisite condition for collective intelligence [3]. On the other hand, Smith [4] argues that individuals do not necessarily utilize all of the relevant knowledge that is available to them when making decisions. There does not appear to be an a priori reason why complete shared knowledge is required for a group to achieve collective intelligence. Furthermore, if the principal objective for the team is to devise a solution to the problem, then the purpose of collective intelligence is to ensure the existence of an adequate level of coherence within the group [3]. Accordingly, the information transfer rate in the planning process must be sufficiently rapid to ensure that differences in relevant knowledge remain relatively small. Since common planing strategies do not address this issue, they have to be extended towards a higher degree of information interchange among team members.

The view of collective intelligence further supports the distinction that can be drawn between: information, coordination, cooperation and collaboration. Traditionally, the degree of communication among team members is dominated by sharing information and, to achieve the highest amount of coordination of shared activities. However, to reach a considerably high degree of collective intelligence the range in communication has to be extended to cooperation and collaboration [5]. Collaboration assumes a high level of coherence among individuals as the team pursues a common goal. Each individual member of the team has fuzzy knowledge regarding the global solution objectives, though being an expert in a particular domain. Collaboration on the other hand has less stringent requirements for intellectual coherence and shared knowledge. The individual members of a team cooperate by carrying out their individual tasks without necessarily having knowledge of all contributions made by others to

the project. In this sense, collaboration could be regarded as a more sophisticated form of cooperation. What is meant in this context can be best viewed if current planing models (e.g. the German Honorarordnung fü Architekten und Ingenieure, HOAI) are analyzed regarding their support of information among team members vs. collaboration among team members. Real collaboration enabling detailed assessment of building components, materials and functions through an interdisciplinary team, can only be achieved if an integrated approach is pursued.

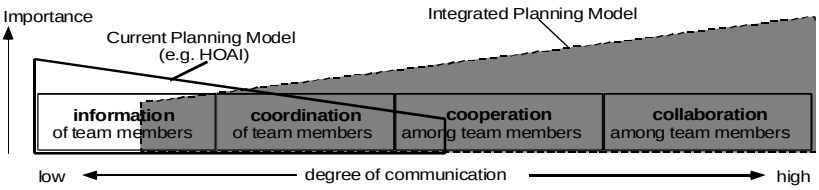

Figure 1: Focus of different planning models

In this prospect, the term integration has to be understood as being twofold. It is important to distinguish between, horizontal (interdisciplinary team) and vertical (building life cycle oriented) integration. As stated previously, in the current situation design teams do neither work together in an efficient way, nor is the planing team constituted when it is most needed; While setting the project goals in preliminary design stages.

Vertical integration requires more transparency of decisions with a high degree of interdependency. Especially the selection of materials or building components is rather difficult due to the fact that selection preferences change over the building life cycle [7]. Tools to select materials and building elements (ECOPRO, ECOPT, etc.) have been developed at ifib with emphasis on transparency over the building life cycle [8]. Incorporated in an integral planing process, such tools can be helpful to accomplish a.) goal assessment of design alternatives and b.) in the education of planing participants who have to learn to think and act more context oriented.

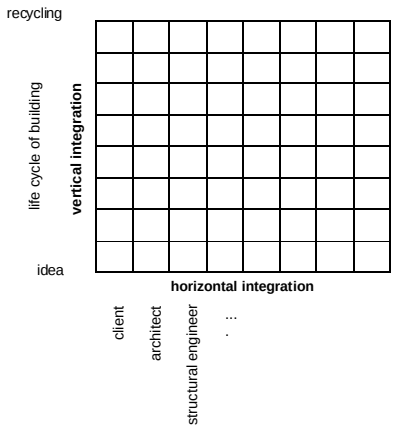

Figure 2: Vertical and horizontal integration

However, integration of the planing process in practice requires also the ability to view a building under different aspects (e.g. views of domain experts) and at different stages over time (preliminary design, design, construction, operation, demolition).

Over the last decade, ifib, IKE and their partners have investigated various tools and techniques, supporting the realization of these goals. It can be assumed that the most important aspect of integration is the environment that connects tools and planing participants. A planing model [9], basis for the development of a planing platform, supporting integrated planing activities, has been developed within the research project INTESOL [6]. Implementation efforts for an integrated planing platform led to work in three related fields:

- **Hardware** (same working environment for all project participants)
- **Software** (predefinition of exchange formats , product model, ifc)
- **Methods** of collaboration

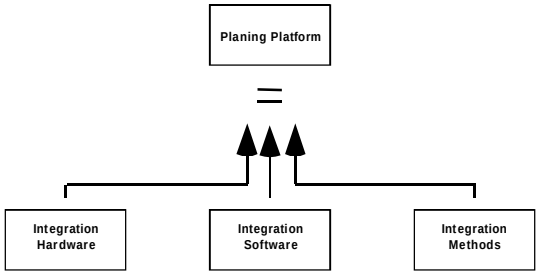

Figure 3: Vertical and horizontal integration

The progress in each field is scaleable and depends on the context in which the work is conducted. Together, the cognition of all efforts account for the latest developments in teaching at ifib and IKE. In the context of design classes (Netzentwürfe) students in Architecture had the opportunity to work and present their project on the World Wide Web (WWW).

4 Integrated Design Class on the WWW

Using standard software for communication and production, students not only had to develop their projects in this new media (WWW), but also discussions with domain experts (structural engineers, environmental specialists, etc.) had to be part of the process. Special focus where preliminary planing stages in which project goals and requirements are set. The didactic of the courses and the work environment let to a high degree of team orientation. The participants had to accomplish technical tasks and also develop a sustainable energy concepts for their building.

The students started to collaborate not only by working together but also in the virtual [10] environment of news groups and Muds (multy user domains [11]). It became possible for all participants of the courses to virtually „walk from desk to desk“ what gave at first a strong impetus for each students work, but also led to a higher understanding of specific problems such as the selection of sustainable materials and elements.

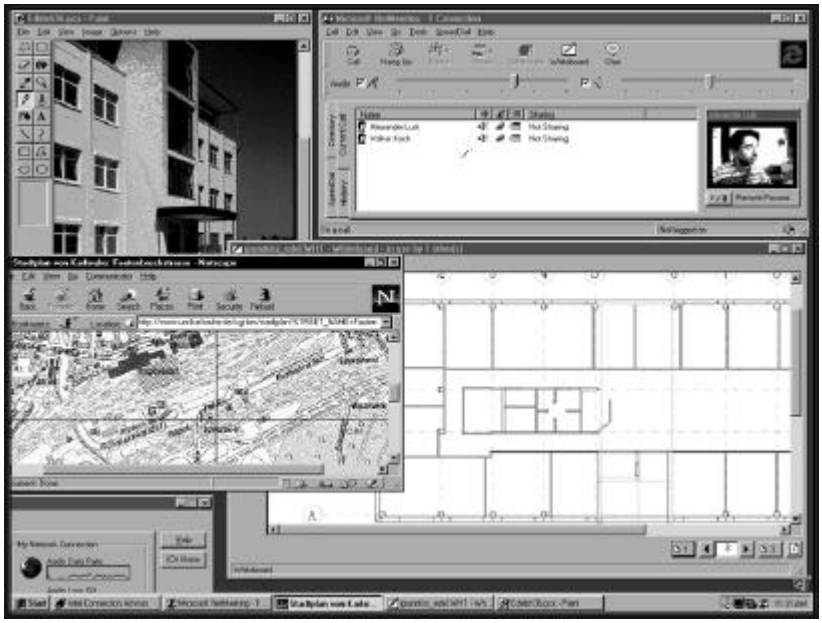

Figure 4: Collaboration platform comprising standard software components

The high level of team orientation led to synergetic effects which was an important experience for students who, once working in practice will have to navigate through virtual worlds while working on projects together with others, not present at the same physical location.

The approach of team orientation among students and collaboration of students with domain experts will be pursued in the coming terms. Teaching efforts not only will be limited to IKE and ifib but also to other participants of different fields such as psychologists and building users.

5 Conclusion

In this paper, the current state in teaching in architecture with special focus on problems among team members collaboration on design projects has been discussed. Current

approaches in building planing have been examined. A concept to integrate sustainable approaches in the design process has been introduced. A brief description of proposed developments in teaching at ifib (University of Karlsruhe) and IKE (University of Stuttgart) has been given and can be further observed on the WWW at:

- http://www.ifib.uni-karlsruhe.de/lehre

Research efforts leading to a computer supported cooperative work platform have been introduced and can be further observed at:

- http://www.ifib41.ifib.uni-karlsruhe.de/Intesol

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