Interdisciplinary Collaboration in the Virtual Design Studio

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Abstract

Drastic changes in technology and economics currently impact common working structures. Moreover, a fundamental move of western societies from industrial and service oriented societies to information oriented societies can be observed. Like others, the AEC industry is also exposed to the challenge of these fundamental changes, not only regarding an ever growing stock of information on building components and materials, but also because of new methods of collaboration to be applied by all participants. As a result, integrating domain specific knowledge into the design process and conversely, conveying design intentions to domain experts, is meaningful in a constantly growing scale.

Utilising advanced technology, a twofold approach in research and education, undertaken at the Institut für Industrielle Bauproduktion (ifib), University of Karlsruhe, is the basis of efforts to create and develop integrating methods of collaboration into the design and planning process. In addition, the integration of AEC practitioners (investors, users, designers, engineers) in the education process provides both drastic changes in the fields of design and construction education of students and a promising approach for life long learning.

The focus of this paper is to present the current state of work and to report on experiences gathered during several Virtual Design Studios (VDS) in which multi-disciplinary participants from various Universities and backgrounds were involved. Platforms for the activities are World Wide Web based applications as well as animations, VR, CAD and video conferencing.

Design Collaboration

The process of design and planing can be described as a process of information flow and manipulation, where goals, parameters and raw data are interchangeable in their role and effect. This process with its various participants and conditions behooves a cognizant, coordinated and flexible planning strategy in order to meet the dynamically changing design goals [Schön 1983]. The inherent complexity of such iterative processes is more so compounded in the design and production of singular products such as ships and buildings. These conditions call for a front-loaded and coordinated planning strategy: the integrated planning approach [Rittel 1970, Rittel 1973, Rowe 1992, LM 95 1994, Wagner 1999]. In this respect, the English term planning comprises any activity related to the completion of a planning project, including design.

Over the past few years, the Institut für Industrielle Bauproduktion has intensified its work on integrated planning environments in both, research and education. In the context of several research projects computer based planning environments and systems have been developed in order to facilitate the information and communication flows necessary to utilize an integrated planning approach. The lessons learned from such research projects [INTESOL 1997, Forgber 1998, Müller 1998] have been

used and simulated in the VDS and their results again serve as a testbed for research work as well as for the refinement of the pedagogical methods in use.

The VDS concept stems from the need to educate students and enable them with skills that will be applicable in real world situations through their lifetimes. In many professions, perhaps moreso in architecture, the need is not so much for specific abilities as for flexible capabilities. The nature of architectural design and the qualities of an integrated planning approach call for strategic thought and dynamic models. The VDS is an attempt to introduce the concepts and train the students through simulated "real world" conditions.

The VDS utilizes existing technologies to create a Virtual Projektspaces to provide communication channels necessary in the integrated planning model. Specific tools such as email, newsgroups, html documents and structured, shared databases are used to emphasize various aspects of a common planning environment. These tools are combined within a design exercise framework which requires the students to confront design problems using non-traditional methods [Turkle 1995, Forgber 1997]. Further, the design problems themselves are chosen for their unconventionality, either in their form or in their format. The students are required to use only internet based presentation methods to ensure a universality in accessibility.

Through the confrontation with unusual situations or design problems [Rittel 1993], the students are trained on how to manage information flows and how to use it in order to achieve collaborative design solutions. The coordination and management of participants, information and processes that is required by current practice conditions is incredibly difficult to teach. Indeed, it could be said that such skills can only be trained. It is the intention of the VDS to carry out part of this training.

The use of internet based tools has the added complexity of exploring and evolving a meaningful methodology with new possibilities for display and communication. This can, in certain circumstances, serve to occlude the goals of the VDS rather than clarify them. Although the results of the studios are graphically enticing, it is the way with which the students are taught (and teach themselves) with these tools that we wish to focus upon.

To emphasize this aspect of the VDS, the students are trained to carry out their design work with the following goals in mind:

- **To gather and assimilate information concurrent to the team consolidation and prior to the actual design activity.**
- **To use a lifecycle oriented approach while developing the design goals and objectives**
- **To increase the communication among team members and "outside" knowledge resources during the design activity**

In the traditional architectural design studio, the students are given a well defined design assignment and are instructed to begin work as soon as possible, usually alone. The students attempt to solve the problem applying a mostly stomach based, intuitive design strategies. The work is carried out in either the student's own home or in communal work spaces at the school with planned consultation and review sessions setting a timetable for work planning. Consultation and criticism is given in sessions where the students first present the work and the Critics react with the allotted time and with their comments. The final evaluation is based upon the internal consistency of the student's logic and the elan with which a solution is provided (or with which it is presented).

The VDS is an attempt to reduce the linearity of the studio environment, the student/tutor relationship, and the way with which the students work with their resources. The framework for the design exercise is parameterized through the assumption of internet based tools to create a workspace through which information will be aggregated and shared [1996]. The workspace redefines the characteristics of the design studio environment by allowing a flexible definition of:

- **the limits of the design assignment,**
- **the proximity of the students' work environment to their colleagues,**
- **the number and makeup of consultants,**
- **the time based constraints for consultation,**
- **the immediacy of response involved in receiving criticism,**
- **the qualities with which the work is evaluated,**
- **and the means by which the work is presented.**

The scope of the VDS is widened through the flexibility inherent in using this approach. There exists the real possibility, however, that by becoming more flexible, the assignment is, for the student, eventually intractable. By redefining the nature or qualities of the design studio environment, the students are often more involved in meta-problems of the assignment than in the core design problem itself. This behooves a large degree of diligence upon the studio tutors to ensure that the students balance their concentration between the process and the product of the Studio. Although the need for this balance is made clear to the students, the realization of its implications varies with each individual and usually requires an attendant individually crafted response from the tutors. This is, perhaps, inherent in the teaching of design.

The scope of the VDS also requires that the expectations of the students be well defined and that the assignment includes not only the production of a design solution, but the investigation and use of the workspace itself. In this respect, an important aspect of the VDS is the establishment of a timetable. The timetable is not, however, one which defines dates for design goals. Rather, the timetable defines dates for setting design goals. This entails, for the students, a not inconsequential amount of research as well as fostering a discussion about how to define the goals necessary to achieve an acceptable, if not overwhelming, design solution.

The timetable also includes activities designed to ensure that the students engage themselves with the communication technologies and the wide band of information, information sources and people available through the use of the workspace. Further, the somewhat rich timetable also requires the students to develop strategies for time management owing to the number and variety of assigned tasks.

A typical VDS last for 4 to 6 months and involves between 15 and 25 students, one or two full time assistant professors, guest consultants (both locally and remotely) and a guest critic (usually a full professor) for the design reviews. During the VDS, the students are required to involve other persons as either consultants (field specific) or as Netnannies. The role of the Netnannies is to demonstrate the rich variety of options easily available (either with or without the internet) as well as to ensure that the students receive an independent criticism of their work. The Netnanny also provides a control that the information presented with the internet based methods is in itself complete and understandable.

The students work alone or in teams of two. It is unclear as to whether one or the other is better for the VDS concept as the results are inconclusive. Rather, the tutors attempt to accommodate the wishes of the students if it is thought that this will foster faster learning and better comprehension. Approximately 90% of the students have no previous experience with actively using the internet or designing world wide web pages. There is no minimum requirement stated other than that the students have at least a working knowledge of computers in general and of at least one or two mainstream computer programs such as a word processing program.

The students are required to have an email account which they receive free from the university computer center. The university is dotted with internet consoles where all students have access to their mail as well as to a rudimentary world wide web browser. The Faculty of Architecture has three

computer pools which are equipped with various software and hardware. These include software for CAD, image manipulation, word processing, calculation, multimedia and layout as well as scanners, printers, plotters and media editing stations. Approximately half of the students have access to other computers either through offices where they work or at home. While this eases the work situation for the many students, it is not required.

The Institut für Industrielle Bauproduktion provides a web site with effectively unlimited disk space for the students. This is reachable by FTP so that the students can autonomously manage their own net presence. The Insitute also provides and administrates a design studio specific newsgroup as a forum for discussions and information exchange. At the start of the VDS, the students attend a mandatory three day crash course in HTML document creation. During the semester, the students have access to consultation for their technology specific problems.

During the VDS, the students are to continually update their web sites and to send email to their colleagues, Netnannies and tutors when changes have occurred. This allows the students to work at their own pace and to reduce the surprises that can occur in a normal design studio. Essentially, the students work in a publicly accessible design space. This often requires a period of adjustment as many students are used to working concealed until they have decided and prepared all of the decisions for their solution. In the VDS, the design process is much more amorphous owing to the irregular and often unforeseeable variety of criticism that arises. Still, there are deadlines set for certain goals. These can be as rudimentary as a room program or as complex as an overall energy concept for the building.

In the VDS, it is up to the students to seek the tutors or consultants for the information they need to create their concepts. This is the reverse from the normal design studio setting where the tutors seek the students (often to check if the work has been done). This too often requires a period of adjustment for many students as they are often trained to respond to the tutors rather than to evoke a response from the tutors. Once these conceptual barriers are overcome, the students essentially steer their own design. The tutors often play a subsidiary role, ensuring only that the students do not take their design solutions into conceptual blind alleys.

The reviews that take place have a different atmosphere than other studio reviews. In the VDS, the work must be made available days before the review itself. this allows all participants to consider the work as well as reactions to it before the review as an event takes place. This allows a more thought out response to the work. Rather than presenting the work in order to elicit a response from the critics, the students are able to present their work as a design solution and to steer the discussion to topics that the student deems pertinent. The decoupling of presentation and response is an inherent quality of the VDS that occurs in all facets of the student / consultant dialogues.

Finally, as the last part of their assignment, the students are required to evaluate the VDS itself. They are to take the VDS concept and its workspace parameters as an experiment in itself and through their personal experience therein, to critically analyze the various aspects, structures and concepts of the VDS.

Project Spaces

As described before, the VDS is comprised of an underlying methodological approach to integrated planning, a web based work environment and an invitation for interdisciplinary, interuniversitary collaboration. The following figure illustrates these three prevailing conditions:

Methodology	Work Environment	Collaboration
Integrated approach through: Restrictive schedule Definition of goals and objectives	All activities are internet based Introduction to HTML and other web specific skills are given through crash courses	Projects involving more then one university industry partners (clients), Netnanies

prior to any design activity **Milestones involving students and tutors from various disciplines**		
Transparent design process	**Commonly established databases**	**Multy disciplinary collaboration on one topic**
Presentation of work in progress (Virtual desk)	**Individual project sites (teams of two are common)**	**Intra-Project Criticism**
Presentation of project results (midterm, final crit, web presentation)		

The Straw Bale House

In the summer of 1998, the Institut für Industrielle Bauproduktion ran a VDS which attempted to instill the lessons learned from the three previous studios while consolidating the pedagogical goals of the concept. The exercise was to design a dream house predominantly constructed of straw bales for a "family" of the students' choosing. the site was located in California, USA near the Yosemite National Park. The site and construction materials were chosen for their novelty and strangeness. Few, if any, of the students had visited this region of California and the use of straw bales as a construction material is virtually unknown in Germany, despite its renaissance in certain regions of the United States.

The students were given a three part timetable starting with a three day crash course in HTML and internet technologies followed by a guided acclimatization with the medium. The students were then to cooperatively work together to design, develop and build a database of information related to the design exercise. Finally, the last 4 weeks of the semester were devoted to the design of the building itself.

The class consisted of twelve students arranged into 6 groups. All of the students had no previous knowledge of HTML and few had even used email prior to the course. After the three day crash course in HTML fundamental, the students were given assignments to create their own logo, design an HTML framework of their individual Virtual Workspace with which to show their work and to find a Netnanny located somewhere which precluded a face to face contact during the semester.

After the introduction to the medium, the students set about mining data. Straw bale construction is enjoying a quiet renaissance in the United States and Canada, but is practically unheard of in Europe. This means that literature about the material and showing previous examples is somewhat sparse, and almost exclusively in English, (not the language of instruction for the studio). The one readily available source of information about Straw bale construction is on the internet. The students had to investigate various sources found, evaluate them, and document or reproduce the information in a database of texts, photos, drawings and anecdotal material.

Concurrent to the database construction, the students were also to determine the needs and programmatical desires of the "family" they chose for the dream house. This in turn was used to present enrage, space and social concepts for their designs. In each case, the tutors strove to encourage the students not to directly design the building from the start, but to work around the periphery of their ideas as they learned more information.

Upon the "completion" of the database, the students were then given the green light to begin the "actual design" of their buildings. Interesting to note was the feeling that the database and concept development were not considered as part of designing by a good part of the participants. After a total of four weeks, the students presented their finished designs which to a good degree, incorporated the

detailed information (discovered through the development of the database) into the conceptual frameworks for energy, space and use developed in the early part of the semester.

The VDS Analysis

The multifaceted nature of the VDS is by no means light on the participants. The students are confronted with several different aspects of completely new ideas and are expected to assimilate and synthesize them into tools with which they can present design solutions. This requires a fair amount of diligence and planning on the part of the tutors. A representation of the learning curve in the VDS is represented in the following figure.

The students start out the semester with little or no knowledge of the subject. They are then given an intensive training in the subject to lift their knowledge to a certain level. This is the first part of the studio (called the framework phase). Herein are the crash courses, seminars and workshops where the students receive an abundance of information in a short time. Noticeable in this first phase is the enthusiasm brought into the project (the students choose freely to attend a VDS) and the high expectations which can arise as a result of the initially steep learning curve

The second phase of the Studio is the guidance phase. Here the students work through the material that they accumulated in the first phase. This period is remarkable in the consistency with which the learning curve flattens. The students do not necessarily accumulate more knowledge in this phase, but rather they learn to work with the knowledge they have newly acquired. The tutors play an important part in this phase in helping the students remain on track to achieve design solutions as well as providing support and encouragement to continue working. It is often the case that the students extrapolate their rate of knowledge acquisition from this phase and become dismayed by the large discrepancy in their expectations from those held in the first phase. Indeed, some students foresee completion of the Studio as impossible.

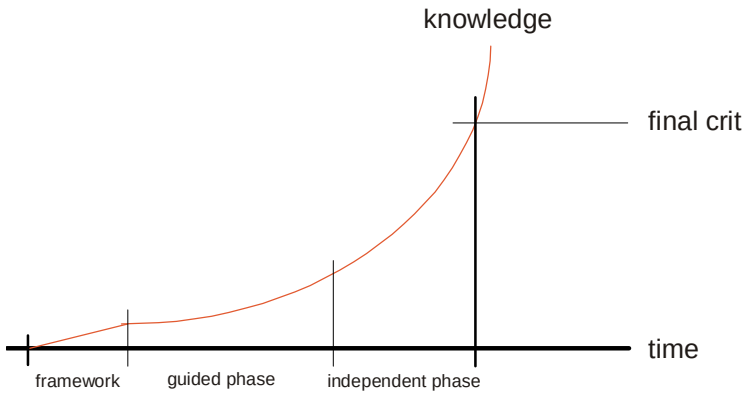

Figure 1: Typical learning curve in the Virtual Design Studio

Gradually, the learning curve tends to increase until the point at which the student's expectations and/or accumulated skills essentially allows the student to independently complete the design assignment. Often the quality of work, the skills acquired and the enthusiasm for the methodology and medium surpasses greatly the expected levels of learning. It could be said that the tutor's real role is to assist the students from the cusp of phase one and two to the critical point where self guided work is possible (the division between phase two and three). After this critical point is reached, the success that the students achieve fosters yet more desire to learn or complete the project. The feedback is then positive in that the input of the tutors is often superfluous.

Conclusion

From May 1998 until February 1999, the Institut für Industrielle Bauproduktion has run seven VDSs over four semesters. The goals of teaching processes and teamwork in addition to other more traditional design skills has largely been met. The VDS is in itself an experiment and is in constant flux as the institute reacts to the experience gained by the tutors and students alike. It is the contention of the authors that the skills acquired in situations like the VDS will become critical to practising any profession, architecture and teaching included. Despite the overwhelming nature of the medium inherent graphics, the predominant skills learned are those of communication and planning within a

dynamically evolving planning situation. This is being reinforced through concurrently run research projects an the Institut für Industrielle Bauproduktion. Feedback from these projects have also helped to shape the VDS further.

Part of the success of the Straw Bale House is attributable to the topic itself. In other VDS assignments, the design exercise itself allowed traditional methodologies to function and, as could be expected, many students chose design and planning approaches with which they were more familiar or more comfortable with. This is not to say that the methods in the VDS are better than other methods, but that in order that the ones prescribed in the VDS be used and function, it appears there must be a necessity present. This principle applies to the consultation with the tutors and other students, to the research of the design topic, and to the presentation itself.

Predominant in the comments from the students is the wish or need for more partners in the studio situation where the communication through the internet is a necessity rather than an augmentation. Indeed, perhaps one of the problems with the concept so far is that the participants seldom change their work and communication habits when old avenues and methods are available. In this respect, the evolution of the VDS must involve other schools and participants. Additionally, the expansion of the VDS to include other institutions is seen as a step toward a virtual school which could span all types of disciplinary, institutional, national and geographical barriers. It is the intention of the authors to allow the VDS to grow into a more multidisciplinary and interuniversitary forms over the next years.

Links:

ifib:	**http://www.ifib.uni-karlsruhe.de/**
Straw Bale House:	**http://www.ifib.uni-karlsruhe.de/de/lehre/archiv/straw-bale**
Virtual Design Studio participation:	**http://www.ifib.uni-karlsruhe.de/de/lehre/vds**

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