Development of a Cooperative Integration System for AEC Design

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Abstract. The paper describes the experience and lessons learned in the development of a cooperative integration system for architecture design in 3D. The developed system is an online cooperative working system to support iterations of composition and decomposition of architecture design with different disciplines such as structural engineering, air conditioning, water and sewage, etc. The system has a 3D design editor which forms the major part of the collaborative 3D distributed virtual environment for online modification and visualization of the design, a project database and a communication tool for synchronous long distance online working meetings. A special geometry error checking module verifies the integrated design in 3D. The system has been evaluated by six life architecture design projects. The evaluation proved that the system is extremely useful and an excellent help for high quality and accuracy control of architecture design projects. The possibility of working in network conference is an advanced feature to facilitate the distance design team work.

1 Motivation, Methodology, and Strategy

The design phase in construction process plays an important role in the final product, the constructed building. However, the design phase is a complex process shared by many specialists, such as architects, structural engineers, air conditioning engineers, energy supply designers, etc. Different specialists usually use different CAD tools that produce their own design results. The whole design process is an iteration of decomposing and integrating designs from different specialist teams at various scales and details. The process involves a high possibility that errors can occur which is extremely costly to correct them when going to site operations. There were no sophisticated ICT tools that could support this iteration process, to aid their cooperative

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design, in order to produce global error free designs. Another factor which makes the difficulty of design integration, amongst many others, is that a considerable amount of the architecture design work is still in 2D, which is neither a convenient format to support this iteration process, nor for error checking and design verification.

Based on this analysis, we have developed an online cooperative working system to support this multiple iteration of composition and decomposition of AEC (Architecture, Engineering and Construction) designs. In addition to this, the system supports many features towards a new way of working in AEC projects.

The basic methodology we have used during the system development, has been a deep investigation on the actual situation in the design phase in Portugal, Spain, Italy and the UK, where we tried to identify the key lacking elements. On the other hand, a close insight into the field of 3D computer graphics, database technology, telecommunication, and computer supported cooperative work was carried out. This allowed us to see the possibility and at what degree the current ICT technology could provide a solution to the AEC practice. A team of computer scientists, architects and engineers have been working closely together, based on the analysis of the current business situation. The strategy is to find a solution to bridge the gap between the current situation and the future way of working. We believed that we could not solve all the problems at once. But we could certainly develop some key elements to solve key scenarios during the design phase.

The paper describes the experience and lessons learned in the development of the system. The system has a 3D design editor which forms the major part of the collaborative 3D distributed virtual environment for online modification and visualization of the design, a project database and a communication tool for synchronous long distance online working meetings. A special module is provided in the editor for users to check geometry errors in 3D and also, to verify automatically the integrated design in 3D, in respect to the occurrence of design clashes and geometric interferences between 3D designs from different disciplines.

The system has been evaluated by six life architecture design projects. The evaluation proved that the system is extremely useful to explain the project ideas to site operators, skilled technicians and clients, because of the availability of 3D models of the building. The system can be an excellent help for high quality and accuracy control of design projects, which can have a very positive impact in the time limits and scheduled construction work deadlines. From the usability point of view, it is an easy to handle and natural to use tool for architecture design team members, as well as for other AEC speciality team members. The possibility of working in network conference is an interesting advantage enabling the distance team design working.

The user evaluation of the advanced features of the system have shown that it is still ahead of the current practice in the architecture design field, as well as in the interface of this area with the different specialties. The ultimate success of the system will depend on many factors including business process reengineering of the whole AEC industry. However, the authors felt that this is the right direction to proceed and that, in time, the industry will accept the trend demonstrated by M3D and will benefit greatly from it.