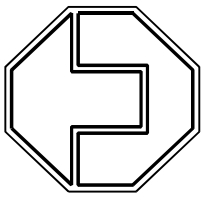
BERICHTE

INSTITUT FÜR BAUINFORMATIK

PROF. DR.-ING. R.J. SCHERER * TECHNISCHE UNIVERSITÄT DRESDEN

INFORMATION



RESEARCH AND LECTURE ACTIVITIES

2005

December 2004

Research at the ”Institute of Construction Informatics” (CiB) is in two major directions, namely:

Applied Informatics and ***Applied Stochastics***

Areas of research are e-work and e-business methods for the virtual organisation, knowledge management, engineering ontologies, distributed systems, mobile computing, e-learning, risk management and earthquake engineering. The scope of research is not restricted to pure engineering problems but captures related business problems as well.

The view of the brochure is directed to the future, i.e. what is planned to be done concerning new topics in 2005, based on the results achieved in 2004. New research topics that have been taken up are: (1) networked business, focused on dynamic virtual enterprising and cross-sectional teams exploiting P2P, GRID and agent technology, (2) evolutionary aspects of building product and process models, (3) use of design patterns as supporting method for virtual organisation implementations, for context-sensitive information management, and for prognosis of earthquake accelerations, and (4) IT supported risk management. Topics covered by current research projects and already outlined in past information reports are not detailed here for conciseness. These are: Product Data Management for Concurrent Engineering and Virtual Enterprises, Legal Framework for the Virtual Enterprise, e-Learning, Engineering Ontology. The latter is part of and has meanwhile been further developed in several of our research projects. Several new R&D projects like InteliGrid (EU) and M³ (German industry) started in 2004.

The institute strongly promotes information technology in research and industry. Prof. Scherer is chairman of the European Association of Product and Process Modelling, which organized its 5th ECPPM conference in September 2004 at Istanbul. The conference brought together again leading European academic and industrial researchers and developers in construction IT, and several running European R&D projects took the opportunity to present their results (see *http://eappm.ecppm.org* or *http://2004.ECPPM.org)*. The next conference, ECPPM 2006 will be carried out by AIDICO at Valencia, Spain in September 2006.

In July 2005 the Institute will host the 22nd CiB-W78 Conference as well as the 3rd International Workshop on Construction IT in Education (see *http://cib.bau.tu-dresden.de/w78/*).

Know-how transfer to the industry has indeed a high priority for the institute in order to not only research but also explore IT solutions. CiB is the German National Information Point for the industry in ProdAEC (*http://www.prodaec.com*), a network of European institutions fostering standardisation in construction IT. CiB is very active in international and national standardization bodies in the domains of IT-related product, process, and document modelling. It holds several chair and vice-chairman positions in standardization bodies.

Since February 2004 the dialogue with the construction industry and IT-specialists has been intensified by establishing the “Dresdner Bauinformatik Gesprächskreis” (Dresden Construction Informatics Dialogue). Workshops were organised in February, May, August and late November 2004, and will continue on a 3 month term in 2005. In June 2004 the University organised the “Innovationsforum Bau” in co-operation with the Federal German Ministry for Education and Research and the Handwerkskammer Dresden (chamber of handicrafts), and in October a combined three-day workshop on IT Architectures for Collaborative Processes and Mobile Computing on Construction Sites.

E-Learning activities - including aspects of mobility - have successfully been continued. The European master course in Information Technology in Construction, co-ordinated by the University of Maribor, Slovenia, officially started in October 2004. CiB contributes to this effort with lecturing courses in “Mobile Computing”, “Software Engineering” and “eBusiness and Data Warehouses”. Professor Jim Garrett (Carnegie Mellon University Pittsburgh) has been actively involved as guest lecturer since 2003.

Research in the areas “ICT in construction management” and “earthquake engineering” was reinforced through intensive information exchange with external scientists. In 2004 we were glad to host Prof. Svetla Vassileva of the Sofia University and Prof. Dimitar Radev of the Rousse University, working with us in the area of earthquake engineering. Prof. Scherer was invited as visiting researcher on “IT-supported construction management” by Prof. Thomas Froese (University of British Columbia,

Vancouver) and on “Earthquake Engineering and Risk Management” by Prof. Vassileva (Sofia University) in August and November respectively.

In 2004 the Institute continued to fruitfully promote its research staff and their results. Having finished his “habilitation” (post doctoral lecture qualification) in August 2003, Dr. Karsten Menzel was promoted in 2004 as Lecturer at CiB. In November Michael Eisfeld successfully defended his PhD thesis titled “Assistance in Conceptual Design of Concrete Structures by a Decision Logic Planner”. His work will be most probably continued by Ronny Windisch, who is currently writing his Diploma thesis in this area. Since August Kamil Umut Gökce from the Technical University of Istanbul is permanent member of the Institute and in October he was approved by the university to receive the PhD scholarship of the Department of Civil Engineering.

The *Errors and Omissions Management Approach* developed by Karin Eisenblätter, Ales Magdic and Ingolf Wiegand under the leadership of Dr. Menzel during the two years WTZ-co-operation with the University of Maribor (Slovenia) won the first prize at the “Build-IT Competition” in Berlin in the category “Construction Management” in February 2004.

Further information can be found at our web pages *http://cib.bau.tu-dresden.de,* which are continuously updated to reflect the state of our research activities.

Dresden, in December 2004 Raimar J. Scherer

Institute of Construction Informatics

		Phone extension	Email name
Head of Institute	Univ.-Prof. Dr.-Ing. Raimar. J. Scherer	3 35 27	Raimar.J.Scherer
Head IT Lab	Doz. Dr.-Ing. Barbara Hauptenbuchner	3 46 41	hb
Lecturer	PD Dr.-Ing. habil. Karsten Menzel	3 49 57	Karsten.Menzel
Leading engineer	Dr.-Ing. Peter Katranuschkov	3 22 51	Peter.Katranuschkov
Secretary	Ms Ilona Jantzen	3 29 66	Ilona.Jantzen
Teaching staff	Dipl.-BW Karin Böttcher	3 45 30	Karin.Boettcher
	Dipl.-Ing. Ök. Ingrid Gerk	3 38 23	Ingrid.Gerk
	Dipl.-Ing. Ulf Wagner	3 57 41	Ulf.Wagner
Researchers	Dipl.-Math. Jörg Bretschneider	3 57 44	Joerg.Bretschneider
	Dipl.-Ing. Karin Eisenblätter	3 57 43	Karin.Eisenblaetter
	Dipl.-Ing. Gerald Faschingbauer	3 42 62	Gerald.Faschingbauer
	Dipl.-Ing. Alexander Gehre	3 57 42	Alexander.Gehre
	Dipl.-Ing. Martin Keller	3 97 76	Martin.Keller
	MSc. Sven-Eric Schapke	3 36 71	Sven.Schapke
	Dipl.-Ing. Ralph Stickl	3 97 75	Ralph.Stickl
	Dipl.-Ing. Ulf Wagner	3 57 41	Ulf.Wagner
	Dipl.-Ing. Matthias Weise	3 46 15	Matthias.Weise
	Dipl.-Ing. Patrick Wilczek	3 97 75	Patrick.Wilczek
PhD students	Jalal Dabagh	3 97 74	Jalal.Dabagh
	Kamil Umut Gökce	3 57 45	Umut.Goekce
	MSc. Shumin Qiu	external	Shumin.Qiu
	Dipl.-Ing. Steffen Scheler	external	Steffen.Scheler

Phone: ++49 (351) 4 63-{Phone extension}
Fax: ++49 (351) 4 63-3 39 75
Email: {Email name}@cib.bau.tu-dresden.de
WWW: http://cib.bau.tu-dresden.de
Regular Mail: Technische Universität Dresden, 01062 Dresden
Packages: Technische Universität Dresden, Helmholtzstraße 10, 01069 Dresden
Visitors: Technische Universität Dresden, Nürnberger Str. 31a, 01187 Dresden

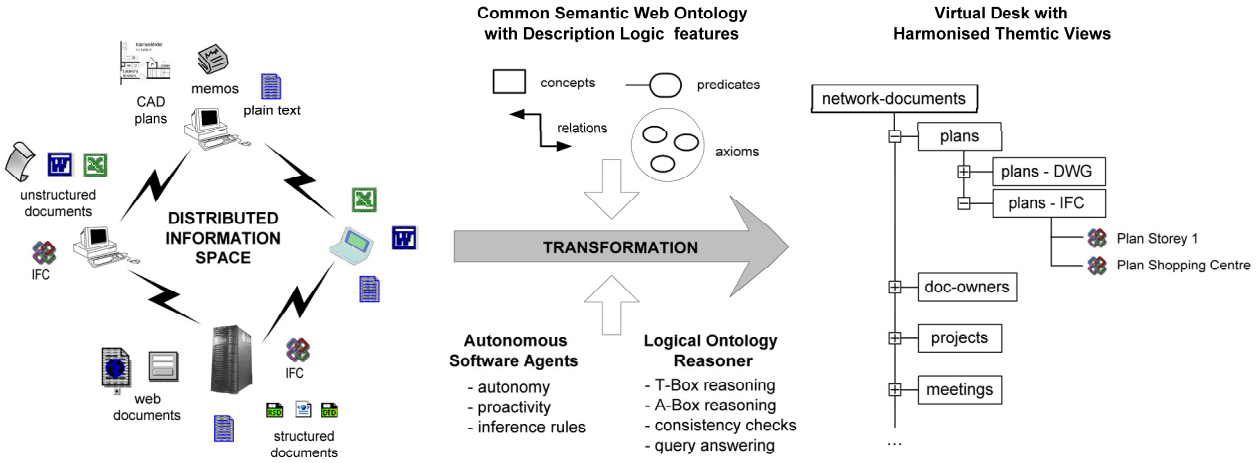
Ontology-based ubiquitous information awareness in dynamic distributed environments

Alexander Gehre, Peter Katranuschkov

Objectives

Multi-stakeholder virtual organisations in the construction industry have to deal with complex collaboration activities within one-of-a-kind projects. The resulting sophisticated information logistic demands of such collaboration activities can be strongly supported by dynamic distributed ICT infrastructures due to their substantially enhanced flexibility with regard to (1) user and device integration and (2) ubiquitous information access.

Our project goal is to extend the potential of such dynamic distributed ICT infrastructures via a coherent approach for *semantic interoperability* that enables (1) precise access to all information related to the task at hand, and (2) derivation of an integrative common view to all relevant resources in the network, arranged along a whole string of contextual aspects instead of only static filenames and locations. This kind of semantic interoperability will be the distinctive benefit compared to current state-of-the-art web portals for project collaboration.



Dynamic generating of a harmonised view for ubiquitous awareness of distributed information resources

Approach

The approach for semantic interoperability will be based on an *ontological framework* that provides for (1) efficient exchange of substantial meta information and (2) the design of intelligent services utilising automated agent-based ontological reasoning, in order to ensure flexibility and extensibility

The ontology framework should fulfil the 'open world assumption', i.e. descriptions of resources are not confined to a single file or scope. Therefore, it is essential to design the ontology in a *layered approach* that allows for extensions both *vertically* and *horizontally*. This means the ontology has to support abstraction layers (from high-level concepts, such as 'resource', to specific concepts, such as 'construction-site-meeting-memo'), as well as the possibility for horizontal extensions for domain/application areas. The general *core ontology* contains the definition of common high-level objects, relationships, behaviours and actions targeting information and network management in the distributed environment. The benefit of such high-level definitions is that each participating node in the distributed network retains its freedom of interpretation of domain-specific concepts but on a high level commits to 'understand' what it is asked to do. In this way, the complexity of the general interoperability problem is broken down to a lean common ontology and associated mappings to the more specific application data structures.

In the research work we use the *Ontology Web Language* OWL, a standard for the semantic web that is capable of capturing substantial ontological information, including also axioms of Description Logic. The technological *ontology enablers* in the software architecture design are intelligent software agents working in the background on every node in the network. They utilise *ontology reasoners* that allow for automated generation of smart views to the network resources by logical A-Box reasoning, considering also the context of the current user task.

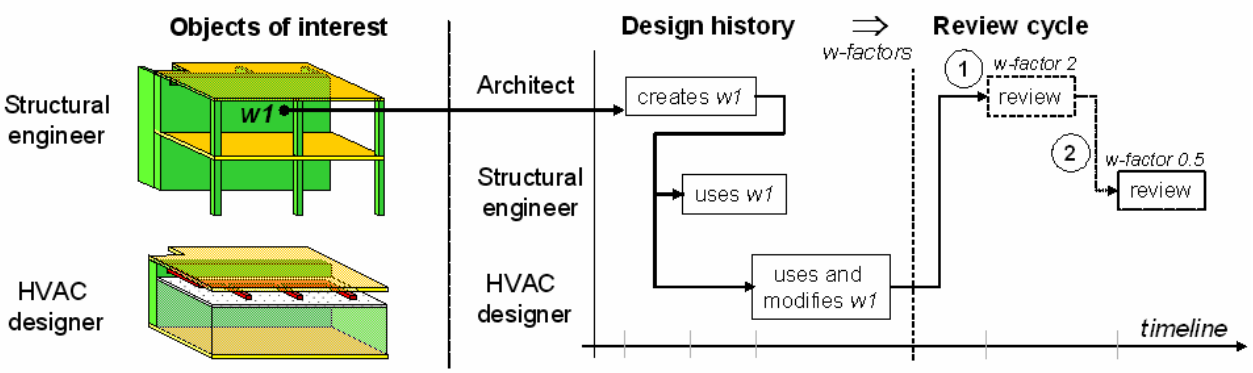
Methods for evaluation of the design history to improve design coordination

Matthias Weise, Peter Katranuschkov

Objectives

Collaborative work requires the management of shared product model data to be up to date and to ensure consistency. Typically, design activities of collaborative work environments are carried out in 'long transactions' which are characterized by repeating sequences of (1) check-out of the needed subset of design data into a private workspace, (2) making design changes within the private workspace, and (3) check-in of the changed design data into the shared workspace to make them visible for the other designers. After a check-in the new model state is not necessarily consistent as a whole and therefore has to be evaluated by the other involved designers for compliance with their design decisions. However, available product model definitions are not capable to capture such dependencies, i.e. to provide information about design changes which may affect other design decisions. Consequently all designers are forced to deal with all design changes which results in many avoidable reviews; as a result, regaining a consistent model state becomes an ineffective process.

Our objective is to improve the coordination process by evaluating the design history. We explore methods which allow to (1) reliably identify only those project participants that are affected by a specific design change, and (2) establish an effective sequence (i.e. ranking) of the potentially affected project participants for each review tasks. In this way repeating work generated by rejected reviews can be substantially reduced, thereby reducing the overall coordination workload.



Schematic presentation of information which can be derived from the design history

Approach

The figure above gives an idea of the information that can be derived from the design history. Depicted are two designers working on the same design data: (a) the structural engineer and (b) the HVAC designer. Both use (check-out) design objects of interest that partially overlap. For instance, the walls and slabs are used by the structural engineer as well as by the HVAC designer. In contrast, the ducts of the ventilation system are never used by the structural engineer and consequently not of any interest to him. By capturing the information when and by whom objects were created or changed, the relevance of the changes can be estimated for each designer. If the wall *w1* was created by the architect and afterwards changed by the HVAC designer, the design change of *w1* has to be reviewed more urgently by the architect than by the structural engineer because the architect may reject the modification making further reviews obsolete. Using this method, which also considers the "*distance in time*" and the "*neighbourhood*" of objects, a weighting factor can be calculated from the set of changes for each designer. This designer-dependent *heuristic factor* represents the importance of the changes and will be used to create a meaningful review sequence for the coordination process.

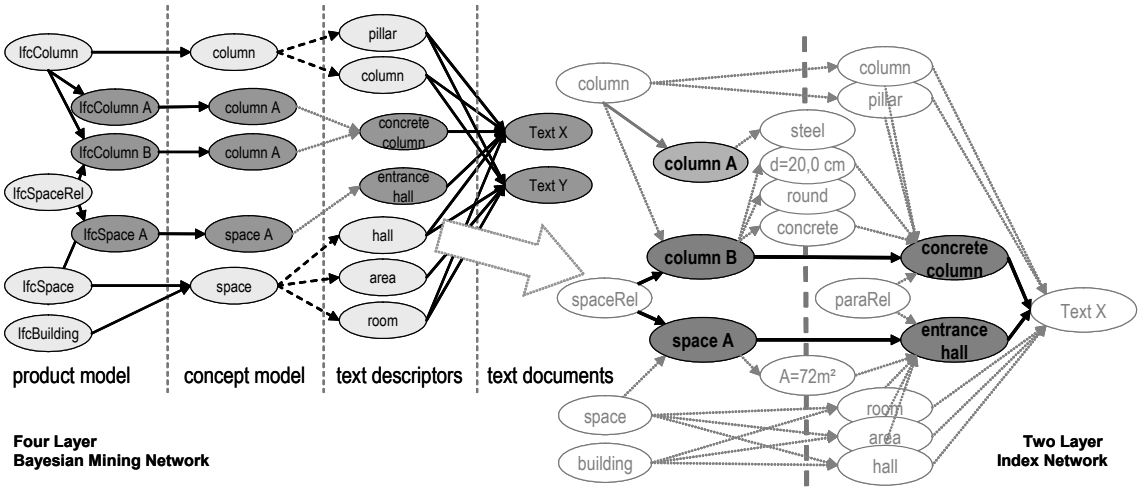
For realisation of the outlined approach we benefit from several methods we have already developed, such as the *General Model Subset Definition schema* (GMSD) for defining the objects of interest, and the *compare algorithm* for finding changes between two model states. These will be completed by a *change-based versioning system*, which will determine the assignments between changes, the timestamp and the responsible designer. Graph-based data structures (directed acyclic graphs) will be evaluated by applying appropriate heuristics to provide a single meaningful weighting factor. The developed methods will be evaluated by using available product model data, such as IFC, and practical usage scenarios.

Interlinking Document with Model-Based AEC/FM Information

Sven-Eric Schapke, Peter Katranuschkov

Objectives

Even with the increasing use of model-based systems in AEC/FM, a large percentage of the business and engineering knowledge will be captured in isolated, often poorly structured text documents. To bridge the gap between model- and document-based information management a four layered Bayesian Mining Network was developed that integrates results of various text, model and context analyses. Utilising product model information as a primary source of engineering knowledge the mining network allows for domain-specific information retrieval as well as for re-organising and re-contextualising the document information. In particular the various text descriptors interrelating engineering concepts with the text content provide for an open, flexible and adaptive mining process. However, this process is also computationally very intensive. The complexity of the network rapidly increases with a more detailed representation of the domain knowledge on each layer accounting e.g. for relationships and facets of model objects and tagged text elements. To allow for information integration and real-time information mining the network needs to be optimised to more purposefully interrelate specific model and text information and minimise the number of nodes and network cycles.



Four Layer Mining Network and Sub-Network for Mapping Analyses

Approach

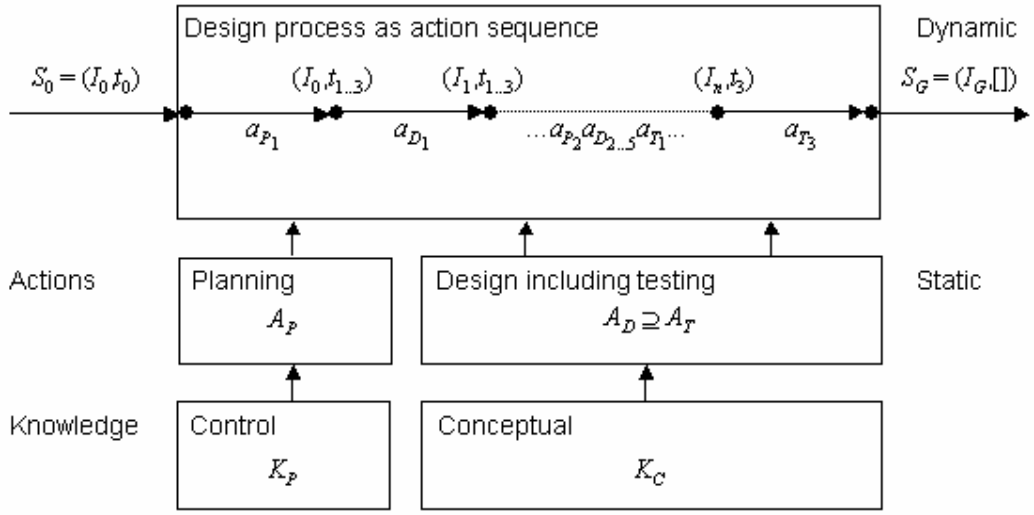
Conceptually, the idea is to build a simplified two layered index from a given four layer mining network, that directly connects specific model-based (represented through model objects or ontology concepts) with corresponding text information. In a three step process the original mining network is transformed (1) complementing it with additional details on project models and documents, (2) re-evaluating and concretising interdependencies among selected variables, and (3) eliminating general concepts, descriptors and shallow interdependencies. In the first step, the concept model layer is complemented with object relationships and attributes to allow for more precise mapping of concept to descriptor nodes. Respective text entities, sets and their relationships can be retrieved from structured text as well as through further information extraction and recursion analyses. The object and text attributes may be canonised, flattened and/or aggregated to achieve a "best match" among the attribute variables and provide for a comprehensive interlinking of concept and descriptor nodes. In the second step, a similarity analysis using Bayesian inference can be performed evaluating the commonalities of such interrelated nodes. The explicit representation of various characteristics of the variables in comparison allows for recognising their wider context and for considering additional evidences such as common owners and predecessors. Furthermore, user feedback may be drawn on to support the similarity analyses. With new interdependencies identified among certain model objects and text entities many of the general, explanatory network variables will become obsolete for the direct information identification. Approaches to learning Bayesian networks such as clustering and XOR-decomposition will be explored to automatically reduce the complexity of the network and merge or eliminate less important concepts and relations in a third step.

Situated Design Planning Assistance for Conceptual Structural Design

Michael Eisfeld, Ronny Windisch

Objectives

Given codes cover only element specific safety and serviceability requirements but leave out the integrity of the structure in terms of load transfer and stability, denoted in the structural concept. Commercial software for computing internal forces and detailed design does not assist the engineer in designing for overall structural integrity because it lacks methods to reason about the structure represented by incomplete information at the conceptual design stage. As a result, designing the structural concept is left to the engineer without assistance. The aim of this research is to reduce iterative cycles by a logic-based method assisting engineers in conceptual design of multi-storey reinforced concrete structures. To achieve this, the system has to represent the conceptual knowledge about conceivable correct structural concepts in a formal *ontology* and control knowledge about *suitable design action sequences*. *Actions* describe how the user via a GUI can develop a *structural concept*, test it for *consistency* by logical reasoning and *plan* his design approach.



Architecture of situated design planning assistant

Approach

The assistance is based on a logical structural model encoded with precise semantics, stored in the *knowledge base*, on which the logic-based method can reason about implicit information to support the concept development. On top of this foundation, a framework for *situated hierarchical planning* of subtasks and design actions is employed to guide the user through the large design state space. The planning technique takes into account how subtasks and actions affect each other and in which situations they should be performed. The representation is based on expressive description logic (DL) and includes constructs for situations, subtasks, actions, and plans. The situation represents the developing structural concept and the current *plan* for *sequencing actions and subtasks*. Subtasks group the set of actions into suitable subsets to achieve a certain subtask and actions describes situation transitions of the developing concept. An interactive planning algorithm processes the representation. Finally, the developed situated planning component was incorporated into the graphical user interface (GUI) of a conceptual design tool to make situated planning for the user in a new design problem situation possible. The planning is realized by an additional GUI component, a so-called *task structure dialog*. The dialog represents the plan as task decomposition tree from which design commands of the GUI corresponding to actions can be referenced. The GUI becomes thereby adaptable to the focused subtask and current design situation. During the design process, the assistant system constantly checks by model construction whether the current structural concept remains consistent with the ontology. The engineer is prompted whenever necessary to revise the developed structural concept to regain consistency or to introduce missing support relations for structural elements to ensure global load transfer.

A Pattern Language to Support SMEs Implanting VO-Networks in A/E/C & FM

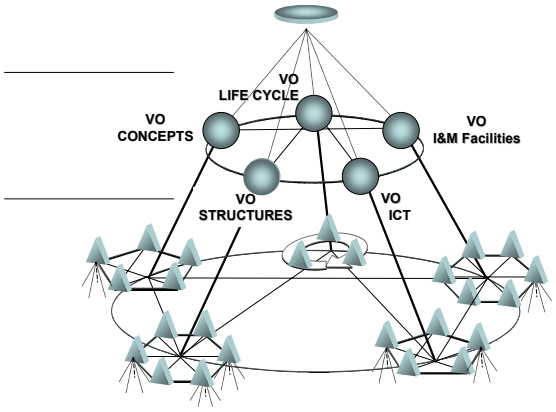
Karsten Menzel

Objectives

The pattern-based paradigm is well established in both, the field of architecture as well as the field of informatics. It is used to support the design of built artefacts and software systems. However, this approach can also be extended to develop an implantation strategy for VO-network structures in the building industry and the area of facilities management. Based on the results of various research projects, such *VOSTER, PORTIKO*, and *E-Sharing* the development of a pattern language to support a flexible and holistic resource management as well as to support context-sensitive information management and representation in VO-networks is the goal of the following research approach mainly driven by the research projects *ArKoS* and *IuK-SystemBau*.

Approach

Pattern languages have a network structure. This structure is described in different levels of detail. Thus one pattern can be described in more detail by using a sub-network of additional patterns and its relations. It is suggest to use the VO-implantation patterns in a sequential, top-down approach. The user shall start by applying general patterns to generate the overall VO-framework and continue by applying life-cycle specific, more detailed patterns in order to manage and control the Virtual Organization.
In the following, the five major classes of patterns are explained:



- *VO-Concept patterns* define the overall VO-framework and map societal, political, environmental aspects towards the specific VO-goals. The application of VO-concept patterns is one major pre-requisite for the definition of VO-structures.
- *VO-Structure patterns* are used to establish the primary VO-structure. The VO-structure must be developed in compliance with restrictions of the secondary internal organizational structure of the participating organizations. However, internal organizational hierarchies will not be assigned to the commonly used VO-structure.
- *VO-Life Cycle patterns* support the generation, operation, adaptation and dissolution of VO-structures.
- *VO-Information- and Communication patterns* allow to easily operate and manage VO-structures in an efficient, complete way by developing a well balanced, open, distributed ICT-concepts.
- *VO-I&M Facilities patterns* support the implantation of appropriate, modular and flexible VO-infrastructure systems. Such systems must be incrementally extendible, re-configurable. Furthermore, such components shall consume minimal resources when operated. Finally it should be possible to re-built them stepwise and re-use parts of them in other configurations. Immobile and mobile Facilities shall support specific VO-concepts and VO-structures.

Within our research group, we are currently working in three specific domains:

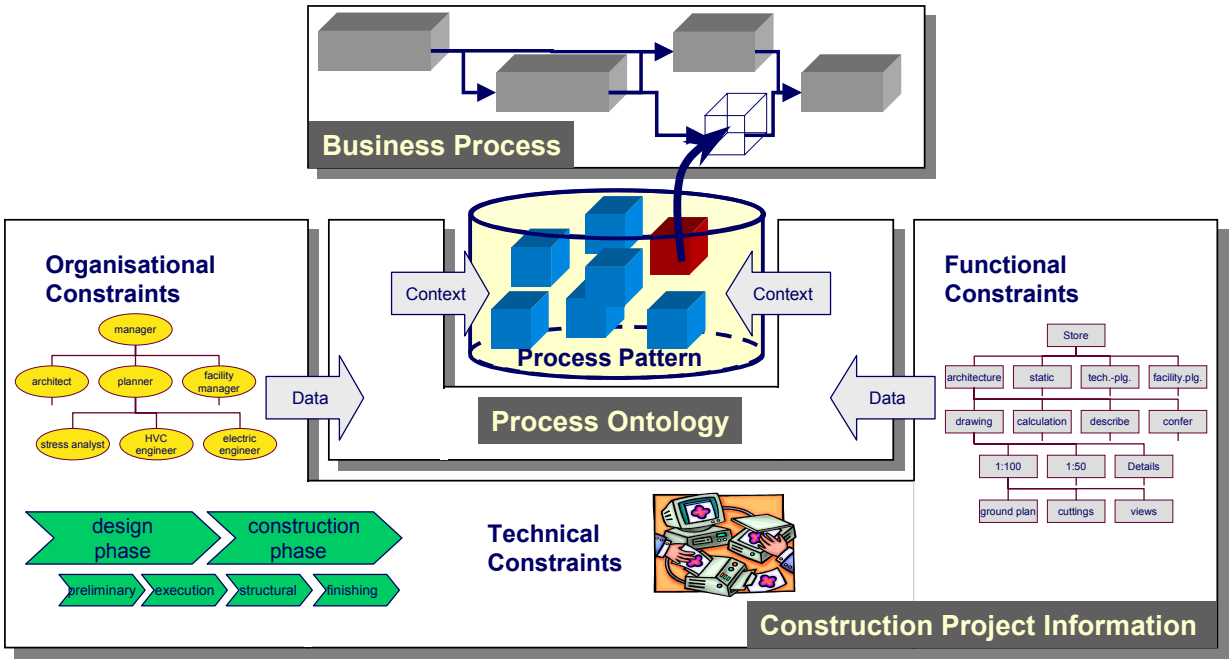
- **VO-Structure patterns**, describing tasks, equipment and roles are currently under development as contribution to the EU-project *E-Sharing* (Ulf Wagner). The ability to merge VO-structure patterns leads to VO-Life Cycle patterns.
- First examples of **VO-Life Cycle patterns***, describing the initialisation and operation phase* were developed by Martin Keller within the *ISTforCE* and *iCSS*-project. They were additionally evaluated in a cross-sectorial context within the EU-Cluster project *VOSTER*. The necessary integration with product models is described in more detail by Martin Keller and will be performed within the *ArKos*-project.
- **VO-Information- and Communication patterns** to support the application of mobile, ambient-intelligent systems on construction sites are currently developed by Karin Eisenblätter as part of the project *IuK-SystemBau*.

Use of Business Process Pattern for Construction Project Management

Martin Keller, Karsten Menzel

Objectives

Complex and dynamic processes characterize most projects in the AEC/FM area. Technical conflicts and modified goals lead to ad-hoc changes of the initial workflow. Furthermore, heterogeneous organisational structures and different IT-Systems hamper the realization of a construction project. Thus, the definition of business processes for construction projects is a crucial task, which could be supported by the employment of generalised, reusable workflow-patterns. However, current project/process management systems provide only little user support to select, adapt and instantiate the most appropriate workflow patterns for the designated tasks, in regard to the project goals and restrictions. Hence, there is a requirement for an collaborative business process modelling framework to enhance, harmonise and eventually standardise the use of formalised business process patterns for initialising and operating construction projects.



Process-modelling framework for the use of process pattern

Approach

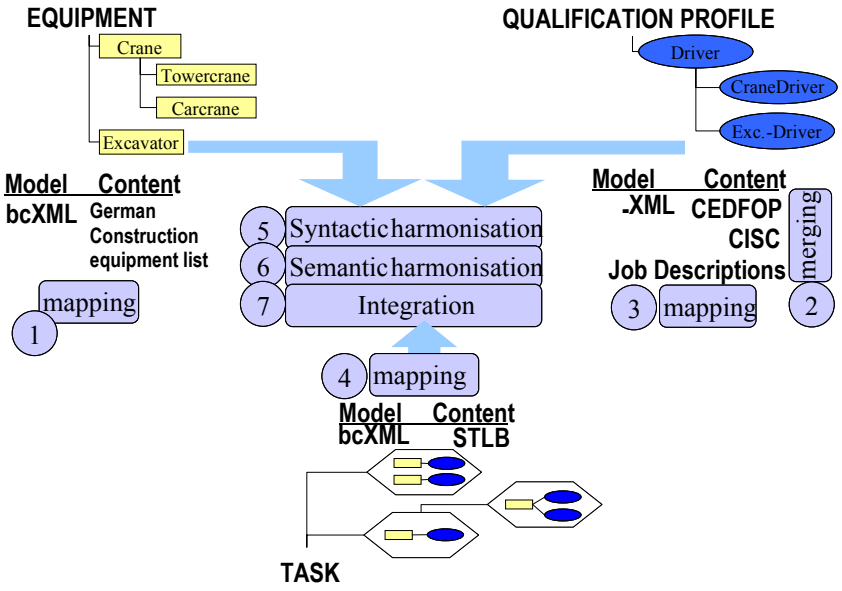
The aim of the research is to develop methods and models for the support and enhancement of business processes modelling in construction projects. For this purpose a semantic interoperability has to be established between the construction project information and the business processes. Information specified within the initialisation phase of the project as well as information developed during the operational phase will be applied as context parameters for the selection and instantiation of the process pattern. Thus, an evolutionary process model will be realized in accordance with the concretion, specialisation and detailing of the project information. To achieve this a framework as indicated in the above figure has to be realized. Basis of such a framework is a library of various process patterns generally describing workflows to perform a certain construction task. These process patterns are modelled in such a flexible manner that they can be aligned to the organisational, technical as well as functional constraints of the project before they are integrated into the business process of the project. In order to select and instantiate the appropriate process pattern the required implicit as well as explicit project knowledge has to be firstly extracted and recorded in a process ontology and secondly managed by a process ontology interpreter. For the development of such ontology the influence factors for the realization of a construction project has to be analysed. This comprises geometrical information and semantic description of the construction objects as well as functional and organisational aspects. The process ontology interpreter will then provide the required context parameters for the instantiation of the process pattern. For a seamless integration of instantiated processes into the existing workflow process-interfaces have to be developed, describing all relevant input and output parameters that has to be transferred between succeeding processes.

An Ontology for Integrated Resource Management in the Construction Industry

Ulf Wagner, Karsten Menzel

Objectives

The construction industry is very seasonal and order dependent sector. It often occurs, that construction equipment or other resources idle in the courtyards of construction enterprises and waste money. A platform that provides the opportunity to share resources or work forces with other enterprises can minimize these idle times if it can effectively bring together the different actors. However, today such platforms lack the possibility to automatically establish connections among different types of information such as the construction work tasks (e.g. erecting a pylon) and related equipment (e.g. the crane) required to carry out these tasks. There is a need for an integrated resource type model based on a cross-domain schemata that supports the integrated management of (construction) equipment, tasks and services. This model needs to be interpretable by services to provide for identifying and combining tasks and corresponding equipment required to perform a certain construction work. The resource type model is to provide an appropriate semantics for resource management and their categorization, including harmonized descriptive attributes and relationships.



Semantic and Syntactic Integration of Resources

Approach

A comprehensive analysis of existing Enterprise Resource Planning Systems as well as standards and catalogues describing construction equipment, tasks, and qualification profiles, will be performed. The analysis is divided into two sub-tasks. Firstly, content information is identified in the areas of construction equipment and tasks as well as information services for the construction sector. Secondly, this content information is compared to existing standardised schemata in order to identify the most suitable models to manage and maintain the information.

Following the analysis, mapping and merging strategies from a German Research Foundation project supporting the integrated use of existing, standardised models and content descriptions will be employed to harmonise and integrate the information. In four steps (cf. figure step 1 to 4) a mapping of proprietary descriptions into common XML standards is performed for existing services. It needs to be described, how the various contend descriptions can be transformed in order to become part of the integrated information space. In the steps 5 to 7 the different models will be harmonised to build an integrated ontology for resource management that can be used to find links among equipment, qualification profiles and services. With this ontology each system can propagate available resources as well as requirements to central management services for information selection and combination.

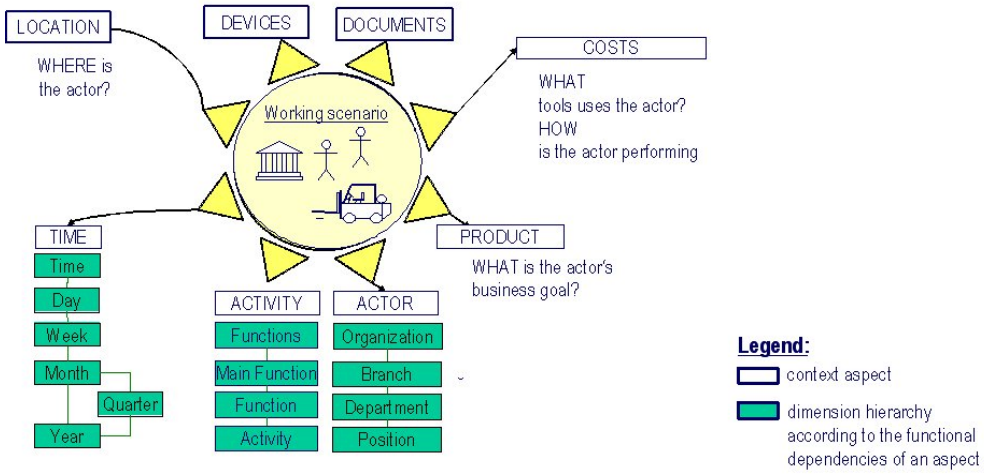
Integrating context in construction site e-work using a multi-dimensional data modelling method

Karin Eisenblätter, Karsten Menzel

Objectives

To foster the acceptance of mobile computing in construction practice, technical shortcomings such as small displays and cumbersome device interaction need to be compensated by intelligent applications. Mobile computer applications should especially consider the context in which they are used in and adapt to it. Therefore, to achieve the goal of effectively supporting mobile e-workers and contribute to an increased project performance we are enhancing mobile IT-systems with highly adaptable mobile user interfaces and underlying intelligent services, providing workers with easy access to context-aware information.

The primary research objective is to develop a strategy that enables flexible integration of mobile computing in the working environment of the construction site. This strategy will constitute (1) a conceptual context framework that lays out the theoretical principles for the intended context adaptivity and (2) a data warehouse platform that serves as baseline for the practical realisation. The specific focus of the research is on representing the relevant context space using a multi-dimensional data modelling method, and on implementing the developed context model within the proposed ICT infrastructure.



Context aspects will be represented as dimension hierarchies of the context model.

Approach

We propose a multi-dimensional data modelling approach to formalize the context information that is describing AEC-specific working scenarios. A *working scenario* is defined as a situation in which an actor is using a mobile device to obtain, enter or modify information that he requires to accomplish an activity at a specific location, time and environmental circumstances. A *working scenario* can be examined from different viewpoints which we call *context aspects*. Each context aspect represents a complex concept, such as time, costs, product etc., that can be represented in multiple ways. Using the multi-dimensional data modelling method each aspect and its underlying functional dependencies can be formalized as a dimension hierarchy of the context model thereby reducing its complexity.

We choose a pattern-based approach to align the application and working scenarios by mapping a working scenario to a *context pattern.* A pattern describes the structural layout to be followed by the configuration and adaptation of a mobile IT-system, or more specifically the adaptive user interface and its underlying information management structure. Software components will be implemented reflecting the requirements described in the *context patterns* supporting dedicated system features (e. g. representation, navigation).

The context framework will be implemented using the data warehouse technology combined with agent technology to properly support the management of collected data and generation of appropriate dimensions for on-site information delivery. Agents will enable the identification of suitable *context patterns* and trigger the configuration of the mobile application. For example, system configuration will be supported by a *dimension generation agent* that adapts the specification according to current working scenario.

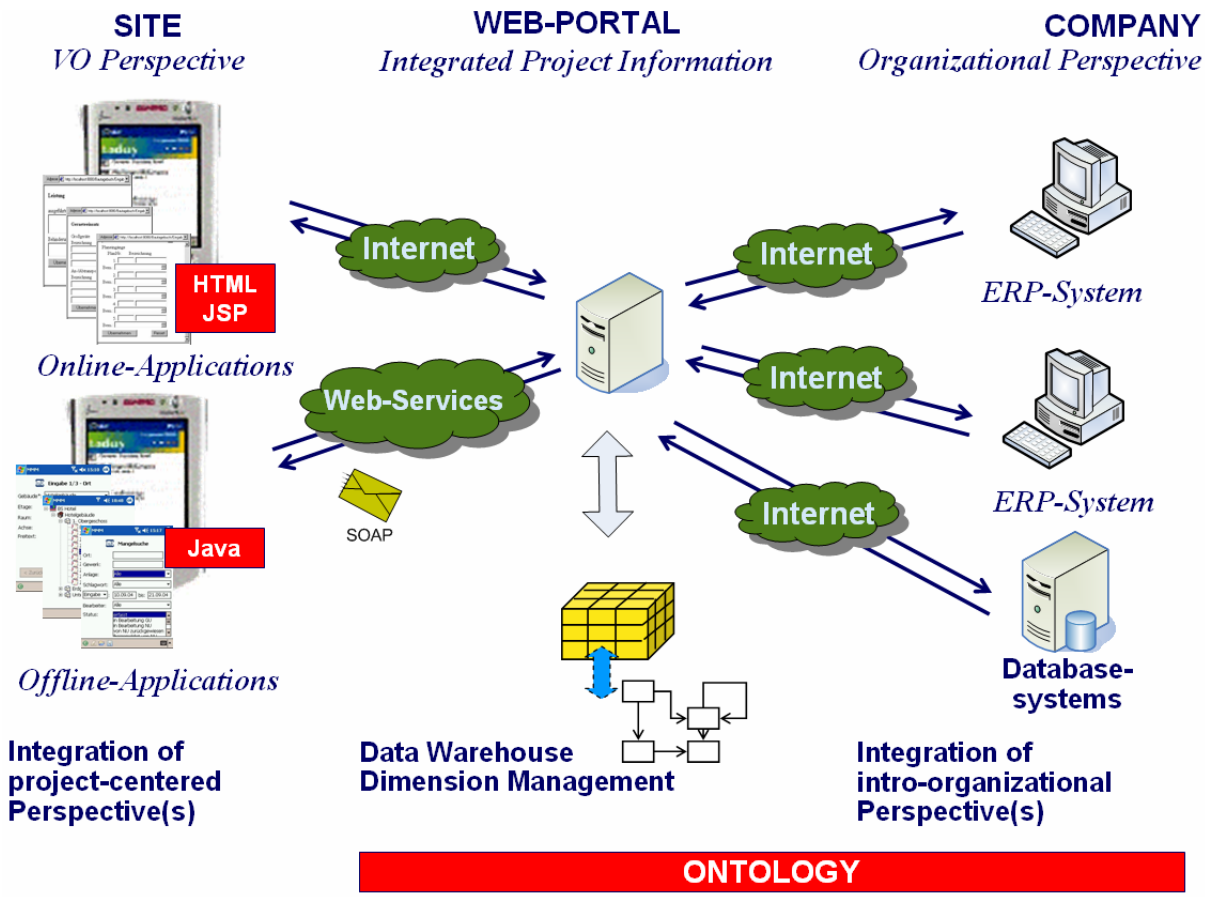
Flexible Software Architectures for Mobile Applications

Patrick Wilczek, Ralph Stickl, Karsten Menzel

Objectives

IT-solutions are to support complete activities or business processes instead of single tasks. Therefore, mobile applications must be an integrated part of existing software environments instead of single solutions. Furthermore, data collected in the field must be transferred into existing standardized data or information models.

Distributed information management is required for efficient handling of integrated mobile applications. Therefore flexible software architectures are needed to represent two different perspectives. The first one is the "intro-organizational" perspective. It shows how to use data from the local ERP-Systems in an integrated way. The second one is "inter-organizational" or project-centred perspective. Within a Virtual Organization it is absolutely necessary that all partners use the same terminology, comparable standards and technical specifications in order to avoid misunderstandings and ensure the utmost quality. The perspective describes how different companies share information originating from different ERP-Systems.



Proposed software architecture

Approach

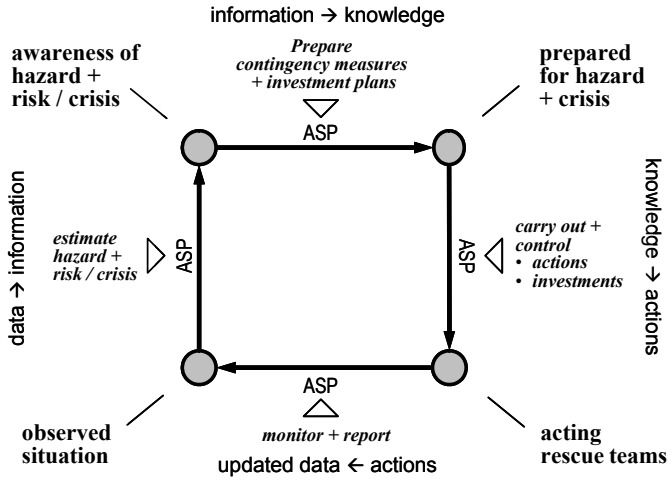
The integration of IT-applications will also be achieved by using common design styles and libraries for the development of common GUIs. A grid-based architecture for distributed information management and load-balancing leads to a reliable environment which can handle different data even in big Virtual Organizations and projects. This supports the context specific calculation and management of "multiple views" needed by different members of the Virtual Organization.

ICT-based Risk and Crisis Management System

Gerald Faschingbauer, Peter Katranuschkov

Objectives

Risk Management can be considerably improved through the recent developments in Information and Communication Technology (ICT). A unified ICT-based approach for Risk Management addressing all involved life-cycle phases is required for the support of decision makers. Currently there exist many sophisticated IT applications for assessment, evaluation and analysis of various types of risks usually focused on one hazard. There is also a large amount of data from maps and satellite images that can be beneficially used for various risk prevention and mitigation measures. However, IT supported Risk Management is not yet a well organised discipline. There are some available standards and guidelines, but a formal approach making full use of leading edge ICT technologies for the improvement of Risk Management is still missing. The target of our envisaged research in ICT for Risk Management will be to combine existing technologies and create a platform which will allow to access and integrate via the network data, information, knowledge and services – in particular simulation, decision support, Risk Management and command & control services –, and to combine them on-line to a coherent, powerful and cost-efficient system for the management of multiple risks.



IT architecture of the Risk and Crisis Management System

Approach

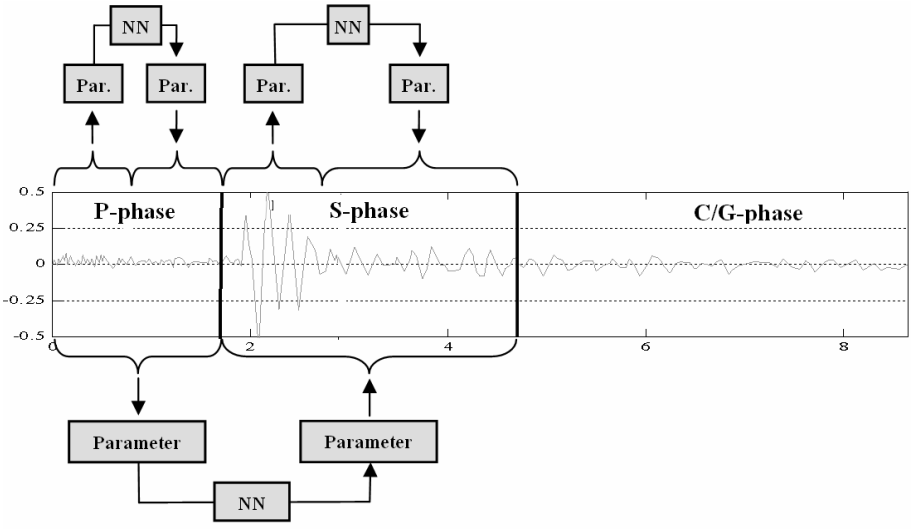
To achieve a unified treatment of all RCM phases and be generic for all kind of risks, the overall process must be generalised on high level and structured in functions and events then sub-structured hierarchically downwards to specific tasks, actors, responsibilities, software tools and information used. The proposed novel ICT-based RCM model (s. Figure) which abstracts on the high-level the RCM process into 4 major event nodes where human decisions are taken and 4 functions the enabled processing edges, representing the stepwise transition "data ➔ information ➔ knowledge ➔ actions." At each node new goals requiring a different focus are set up, and a mapping between different data models corresponding to the different mental models of the actors occurs. In particular, Node 1 represents the observed situation (data, which is then processed by engineering experts to estimate hazards and determine vulnerabilities and risks), Node 2 represents the achieved awareness of hazard and risk (information, which is processed by decision makers to develop adequate prevention/mitigation actions), Node 3 represents the preparedness for a hazard (knowledge, which is processed by risk and crisis management authorities to set up appropriate action plans), and finally Node 4 represents the acting of rescue teams actions (new data is collected from the actual and evolving situation monitored by sensors and in addition all involved people, starting the next RM cycle). The platform architecture reflects this structure to provide a logical clustering of appropriate services at each edge of the overall process thereby enabling fast and efficient access to sensors and devices (to inform and direct people), software tools, multi-layered cadastral GIS maps, databases and knowledge bases – directly, or "plugged in" via grid-enabled Application Service Provider (ASP) technology. This generalised structuring of the RCM process will allow dual use of the platform both in the planning and preparation phases, where hazards and their consequences are simulated (long-term use), and in the case of a hazardous event, where critical actual situations have to be dealt with (short-term use).

Forecasting of Strong Motion Seismic Waves

Gerald Faschingbauer

Objectives

Real-time forecasting of seismic strong motion is an essential requirement for active structural control. In our previous research, founded by DFG, we observed, that seismic acceleration time series are dominated by three processes (P-, S-, C/G-Waves), which are significantly different, but can be modelled uniformly inside of each process. This means, the whole process is a heterogeneous and non-stationary process, and not an homogeneous one as commonly assumed. The result of our research (NATO, PST.CLG.979333) in the field of real-time forecasting is a methodology for real-time prognoses of a homogeneous, non-stationary process for a timeframe t/10 on the basis of a measurement for the duration t assuming stationarity in the considered window t. The envisaged target of our future research is to take into consideration the heterogeneity and develop a methodology for a heterogeneous, non-stationary process. Two different outcomes are expected: (1) In-phase prognosis – the further development of the time series within one wave phase based on the methods in the project founded by the NATO and (2) Inter-phase prognosis - the prognosis of the S-Phase based on the recorded P-Phase, and the C/G-Phase from the P- and S-Phase.



Online Forecasting of S-Wave parameters with given P-Wave parameters

Approach

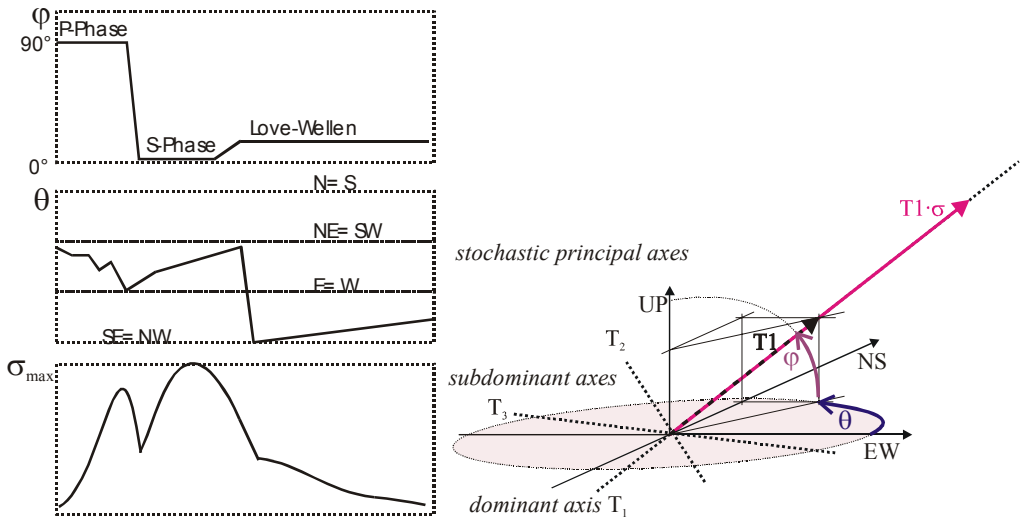
As a first approach we will use the Neural network method to forecast the parameters of the parametric load model developed in the previous research founded by DFG, which is, based on Priestley's evolutionary stochastic process model. The parameters are a set of parameters for the spectrum (damping, the resonance frequency and the average spectral amplitude f, ζ and S0) and the parameters of the amplitude modulation function τ and c. A Neural Network, trained with a set of classified accelerograms, will be used to forecast the parameters of the parametric load model on the basis of the parameters of the already recorded time series. As an additional classifier the distance (near-, middle- and far field) should be considered to offer a more significant allocation of the prognosis model to the particular time series. The phases itself will be identified and determined using the characteristic of the time dependent stochastic principal axes. The distinction of characteristic wave phases results in two different prognosis requirements: (1) In-phase: based on the records of a timeframe the input parameters of the parametric load model will be estimated through a Neural Network. On this basis the ongoing time series will be forecasted. (2) Inter-phase: the starting time and the parameters of the S-phase will be forecasted on the basis of the determined parameters of the previous P-phase. On this basis the ongoing stochastic acceleration process can be determined. Currently the only known relationship between P- and S-phase is that in a homogeneous, isotropic, linear-elastic medium the velocity of the P-Wave is proportional to the velocity of the S-Wave. This holds for the resonance frequencies of P- and S-Waves as well. Due to this sparse information, the estimated parameters must be permanently updated. Through recording of the measured values and forecasted values, the emerging trends may be identified. The difference of these trends is an indicator for the reliability of the forecasted time-series, which can be used to modify the forecasting model appropriately.

Identification of 3D seismic strong motion patterns in near field records

Jörg Bretschneider

Objectives

The acceleration process at sites in the near field of strong earthquakes consists of several 3D seismic wave fields, which have different, distinctive characteristics and overlay in complex patterns both in the time and space domains. These patterns reflect both the type and sequence of body wave fields generated by the rupture process and also of indirect wave fields like surface waves generated by certain topographical conditions in the environment of the site, which have great influence on the seismic load at a building at the site. By empirically developing methods which can recognise the recurring patterns of strong motion acceleration and identify the source and characteristics of the corresponding wave fields, we want to improve the predictive performance of wave based seismic load models previously developed in a DFG research project by extending the number of distinguished rupture phases as well as the range of wave types modelled therein. We are going to extend the approach to waves originating from regional and topographic response, especially Rayleigh surface waves. Our wave pattern identification may supplement near field inversion procedures for rupture allocation.



Wave patterns in the course of the stochastic principal axis coordinate angles φ and θ and autocovariance σmax (definition right side) indicating direct P and S waves radiating from a one phase moving rupture near the site with rupture strike changing from East to North-East as well as surface (Love) waves originating from a South-East – North-West striking topographic boundary.

Approach

Time-dependent stochastic principal axes and principal planes are used as a basic tool to visualize patterns of the 3D particle dynamics of the wave fields. The 3D characteristics of dominant wave fields can be studied in the course of the dominant principal axis of acceleration, expressed by the course of two independent angles θ and φ. We will first extend our approach, which is based on one phase, unidirectional rupture and consisting of 3 wave fields of direct P and S wave fields as well as a phase summarizing indirect wave types, to cover also multi phase and multidirectional rupture mechanics. Possible wave patterns are formally developed by simulating seismic wave fields with simplified rupture models and verified by empirical investigation of recorded data.

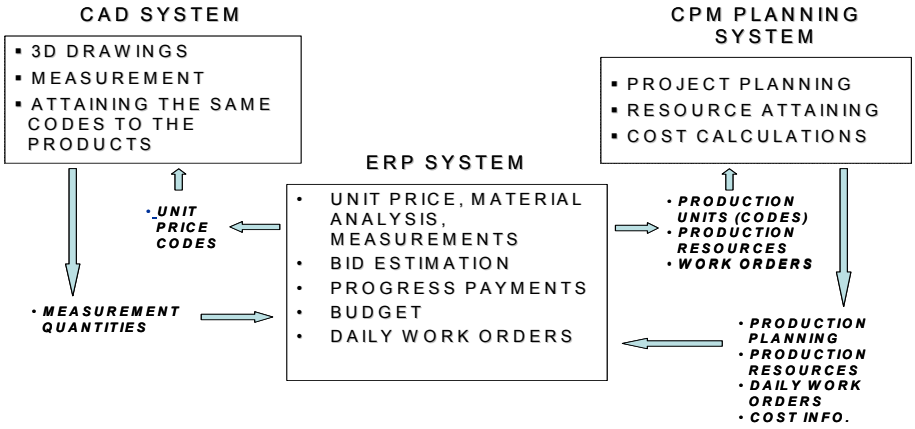
In order to cover subdominant wave fields and waves with planar dynamics as well, we investigate indicators for those waves in the course of the subdominant principal axes and also in the course of the corresponding uncorrelated autocovariances σ. A time delay estimator for the various principal axes should give an indicator for the existence of both dominant and subdominant Rayleigh surface waves. In order to identify the secondary elliptical axis of Rayleigh, which is aligned with their regionally determined travelling direction, several indicators are evaluated simultaneously.

Integrated Construction Management Based on Standardised CAD–ERP–CPM Interoperability

Kamil Umut Gökçe, Peter Katranuschkov

Objectives

In the last years several systems integrating CAD, ERP and CPM tools have been developed. Such systems typically combine construction site and company databases thereby allowing to improve project/cost control, reduce operation costs, increase work efficiency, and quickly respond to changes in the construction environment and the market conditions. However, they largely lack generality in terms of *data and process interoperability*. ICT-supported construction project management (CPM) processes are mainly defined in terms of the used applications, and not on the basis of generalised industry requirements; similarly, integration of product, process and cost information is based on the specific internal data models of the used component CAD/ERP/CPM systems, and not on generally applicable and hence standardised data models. All this significantly decreases flexibility, information exchange between the component systems, and, last but not least, inter-enterprise cooperation and knowledge transfer. The objectives of this research are to (1) generalize and formally describe CPM processes so that interoperability over a broad spectrum of applications is facilitated, (2) establish a common information model for construction project management based on the data schemas of the IFC standard, thereby providing for the needed integration of product, process, cost and management data, (3) provide interoperability methods to integrate legacy systems, and (4) develop an algorithm for completeness check and a CPM assistance tool to interactively prove and ensure context-relevant data completeness.



Principal data flow in an interoperable CAD-ERP-CPM environment

Approach

The RTD work is strongly based on using and appropriately combining standardised methods for requirement analysis (quality function deployment, critical success factors, use case analysis), process modelling (IDEF0, UML, and especially the ARIS methodology) and STEP-based product modelling (EXPRESS, EXPRESS-G), to identify and formally describe the necessary IFC extensions for CAD-ERP-CPM interoperability. The system APIs will be developed using the object-oriented modelling methodology, and the system itself will be established as an integrated client-server environment, enabling to *plug in* all component tools as services via a common GUI implementing the *Web Services* concept. Interoperability constructs will be defined on the basis of state-of-the-art analysis of CAD, ERP and CPM systems and relevant industry requirements, whereupon CPM processes will be identified, generalised and appropriately formalised. For the definition of a specific *CPM extension model for the IFCs*, the general modelling methodology adopted by the IAI will be used as baseline, whereas definition of specific CAD/ERP/CPM sub-views for the purposes of integrated project management will be carried out using the dedicated *generalised model subset definition language* (GMSD) developed recently at the Institute of Construction Informatics. A comprehensive study of the current IFC Project Model will reveal entities, attributes and relations covered/not covered by IFC with regard to the identified generalised CPM processes to clearly identify gaps, modification, extension and re-structuring needs. For the software realisation and the verification of the conceptual approach, three established systems will be used, namely Allplan (CAD), AVINAL (ERP) and PRIMAVERA (CPM).

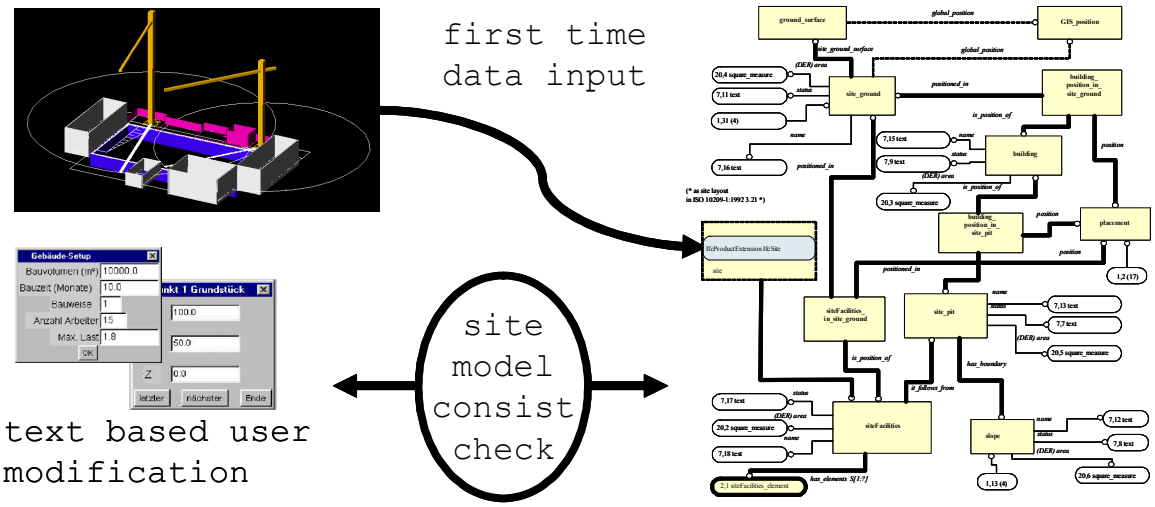
An Adaptive Process-Networked Product Model for Site Installations

Steffen Scheler

Objectives

In current practice the two major goals of each construction project are the completion of the project in time and with high quality, and the achievement of a profitable economic result. But in this way the cost effectiveness of site facilities is most often neglected as a separate economic factor which decreases the overall economic result.

This research work describes a method for fast and easy cost estimations for site facilities that does not require to go into deep and detailed cost-volume-profit analyses. The developed method allows to realize the pure site facilities costs using well-defined normative and heuristic rules from engineering knowledge, together with typical construction details of site installations (e.g. for accident prevention). An evolutionary site model is suggested to accommodate changes due to partial modifications of the initial (design) product model for site installations. In this way different alternatives can be compared more accurately enabling adequate scheduling of the site facilities costs depending on the design cost estimation and the actual construction progress and demands.



Site model consistency check as the main tool between data input and user modification on project site

Approach

Typically, at construction start site installations are simple, requiring only site facilities on a low level (e.g. a few containers). Consequently, the product model at that stage will be simple as well. However, when some additional site facilities are needed (crane and therefore haul roads, container etc.), the site will no longer be simple and another product model will be required. Thereby the cost summary of the resulting more complex site model will also change, but not the cost model.

An essential role is attributed to the dynamic substitution of partial models to provide for simulation and evaluation of alternative solutions. The consistency of the overall model is thereby maintained through respectively carried out re-classification of the involved product objects. The re-classification itself is achieved by a dynamic classification method implemented with the help of a tool from the domain of knowledge representation technology.

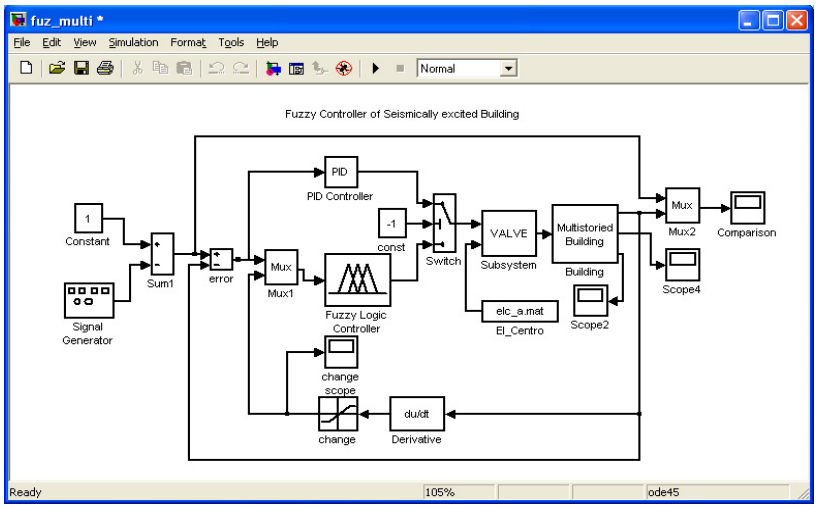
The innovative aspect of the approach is in the dynamic modification of whole model parts and not only the re-classification of instances in a single model. The provided comparisons between alternative site facilities instantiations support the concurrent decision making process through all phases of site planning and construction, e.g. by parallel re-scheduling of activities by the project leader, by design changes made by the contractor for better constructability, by considering the mutual inter-dependencies of time and cost aspects etc.

Simulation of fuzzy logic based structural control system of buildings under earthquake loading

Shumin Qiu

Objectives

Structural control is an attractive design methods to enhance the safety and reliability of structures subjected to earthquake without changing the architectural design. The objective of this research is to contribute at a novel level to the improvement of safety and dynamic performance of civil buildings by introducing fuzzy logic control technology. Our work is focused on developing a fuzzy logic based seismically excited structural system for suppressing dynamic vibration of buildings which is demonstrated and verified by computer simulation. The conventional seismic structural control systems are usually designed on optimal control theory. The characteristics of ground motion and the uncertainties on structural performance are not considered normally. We have proposed and developed a seismic structural control system, which include the uncertainty and characteristics of ground motion in the control system. The simulation is implemented in MATLAB/Simulink development environments on a personal computer. This ongoing research endeavours include the validation of the more complex active control system; both in simulation and on an actual platform. This simulation enables a more effective development of behaviours using automated optimization techniques such as genetic algorithms and neural networks. The control modelling schema is shown as following in MATLAB environment with Simulink.



Simulation environment of fuzzy logic based seismically excited structural control under MATLAB/Simulink

Approach

The simulation of proposed fuzzy logic based control system can be completed in following steps:

- Modelling of fuzzy logic control system: The model is designed with expressive powers of representation embedded in linguistic variables and improved methods of interference based on fuzzy logic for seismically exited building. The uncertainty in structural performance and capability and the characteristics of ground motion are expressed in linguistic values.
- Compilation of fuzzy rule bases into fast access lookup tables. These tables can be used by a simplified run-time engine to determine the FLC's crisp output for a given input.
- Implementation with MATLAB/Simulink package: This development tool provides an integrated environment for computation, visualization and programming to design fuzzy controller and allows us to define the inputs, outputs, data set, and initial rule sets simply. The performance of designed fuzzy control system is tested by the simulation for multi-storied seismically exited buildings.

Research Contracts

Title:	**InteliGrid – Interoperability of Virtual Organisations on Complex Semantic Grid**
Financial Support:	EU, IST-2004-004664, **inteliGrid**
Person Years:	30 (total), 5.3 (CIB, TU Dresden), Duration 2.5 years
Approach:	InteliGrid is extending the semantic grid paradigm to support dynamic virtual organizations (VO) that collaborate on the design, production and maintenance of products that are described in complex, structured, product model databases. The hypothesis of the project is that the collaboration platform - the semantic grid itself - must be aware of the business concepts (e.g. car, plane, house) that the VO is addressing. The grid itself needs to commit to the product's and process's ontology thereby evolving into an ontology committed semantic grid. The goal of this project is to create an architecture and a prototype for such an infrastructure, based on existing grid middleware and test it in the context of industries mentioned above. The main results are the generic business-object-aware extensions to grid middleware, implemented in a way that would allow grids to commit to an arbitrary ontology. These extensions are propagated to toolkits that allow hardware and software to be integrated into the grid.
Partners:	University Ljubljana (Slovenia), VTT Technical Research Centre of Finland, ESoCe Net (Italy), Poznan Supercomputing and Networking Centre (Poland), Obermeyer Planen + Beraten (Germany), Conject AG (Germany), SOFiSTiK Hellas (Greece), EPM Technology (Norway).

Title:	**e-Sharing – Resource Sharing Constellations**
Financial Support:	EU, IST – 2001 – 33325, **e-Sharing**
Person Years:	28 (total), 3.1 (CIB, TU Dresden), Duration 2 years
Approach:	The objective of the e-Sharing is to design, develop and evaluate a service provided by a third party for the efficient management and sharing of idle resources, namely human labour or equipment. Companies are lessors and lessees as well. Resources shared through e-sharing can be of any type described by a resources type model designed in the e-Sharing framework. e-Sharing target is to provide an intelligent decision support system to companies letting them describe the tasks they need to accomplish and proposing them to use a combination of resources for the accomplishment of the described tasks. The selection of the resources is based on several factors such as productivity, leasing costs, functional costs, possession costs, time constraints etc. e-Sharing aims in assisting the company-users to decide whether to lease resources or use their own and in providing for an alternative channel for the enterprises to exploit expensive and rare resources when they remain idle.
Partners:	Intracom S.A. (Greece), Sema Group sae (Spain), Pouliadis (Greece), Helsinki University of Technology (Finland), AKTOR S.A. (Greece), Müller-Altvatter (Germany), Dachdeckermeister Dittrich (Germany).

Title: **ArKoS - Architektur Kollaborativer Szenarien**
(Framework and Architecture to Support Collaborative Scenarios)

Financial Support: BMBF (German ministry of education and research)

Person Years: 30 (total), 3.4 (CIB, TU Dresden), Duration: 3 years

Approach: The main objective of the ArKoS project is to improve the management of collaboration and cooperation between different enterprises from a conceptual to the system level. Therefore the project will start with a State-of-the-Art analysis and requirements definition. Derived from this a comprehensive architecture, which consists of modelling techniques on macro and micro level, integrating meta-models and a modelling tool, will be established. In a second phase domain-specific reference models and software systems will be developed and validated. Within the project the building industry will serve as the reference-domain for design and validation of the aspired methodology.

Partners: Institut für Wirtschaftsinformatik (IWi) am Deutschen Forschungszentrum für Künstliche Intelligenz, Saarbrücken; Inst. für Wirtschaftsinformatik & BWL, Universität Mainz; FG Bauinformatik, FH Gießen-Friedberg; Nemetschek AG München; f:data GmbH Sömmerda; WeltWeitBau GmbH Berlin; INTERACTIVE Software Solutions GmbH, Saarbrücken, Müller-Altvatter Bauunternehmung GmbH & Co. KG, NL Dresden

Title: **IuK-Sytem Bau - Information and Communication System to Support Construction Management Activities in SME using mobile, networked technologies**

Financial Support: BMBF (German ministry of education and research)

Person Years: 9.9 (total), 2 (CIB, TU Dresden), Duration: 3 years

Approach: Development and prototypical implementation of a mobile information and communication system for controlling construction activities in SMEs using PDA or "handhelds", accessing data through a web-based portal, and re-engineering of existing business process models. Research is focused on context-based interfaces and context-focused information applying data warehouse methods. Information will be represented in XML and structured according to the BC-XML model. The data model will be implemented using a distributed, object-relational DBMS. For the implementation we are using commercially available software packages and hardware components ensuring that SMEs will be enabled to use cost-efficient, up-to-date, easy to learn information and communication technologies.

Partners: TU Dresden, Institut für Baubetriebswesen; Claus Dittrich Dachdeckermeister GmbH & Co. KG, Dresden; Müller-Altvatter Bauunternehmung GmbH & Co. KG, Niederlassung Dresden.

Title: **Cooperative model for monitoring and control of diverging design states – Identification of design data conflicts**

Financial Support: DFG (German research foundation), Sche223/27-3

Person Years: 2, Duration: 2 years

Approach: Concurrent parallel design inevitably leads to diverging data states. Therefore methods are needed to recognize the emerging differences and to transform the various concurrently modified domain data models into a consistent state.
The project continues the work of a prior DFG project that dealt with the development of a declarative mapping specification language for building construction and realisation of a respective mapping engine to enable modelling object transformations between heterogeneous representations. The work in this stage of the overall research on the subject is particularly dedicated to the tackling of

differences occurring by the concurrent modification of partial models by different designers. This includes: (a) identification of changes, (b) classification of detected differences and notification of relevant actors, (c) prioritising the differences to help subsequent co-ordination and reconciliation processes, (d) version management.
The implementation is carried out within the environment of a Product Model Server developed at CiB, thereby enhancing the existing functionality of the latter.

Title: **M³ - Mobiles Mängel Management**
(Errors and Omissions Management using mobile technologies)

Financial Support: Construction and IT-Industry

Person Years: 1, Duration: 1.3 years

Approach: The project aims on effective technology transfer to the construction industry. This is achieved by using synergy effects between the research projects "ArKoS" and "IuK-System Bau".

First an "in-depth" process analysis on different construction sites in Germany was performed. Intensive re-engineering activities carried out in close co-operation with high-level management and senior engineers led to strongly improved process models in the field of Errors and Omissions Management.

Based on these results three software prototypes were developed. The *Construction Diary-Application* and the *Complaint Management-Application* represents a closed MVC-architecture using a common repository. The *Errors and Omissions Management-application* is designed for off-line data acquisition on construction sites using a two layer architecture. The data exchange is managed by web services based on the SOAP-protocol.

Partners: Bilfinger Berger AG, Mannheim; ACI EDV-Systemhaus, Dresden;
Müller-Alvatter Bauunternehmung GmbH & Co. KG, NL Dresden;
ePlus Mobilfunk GmbH, Panasonic Deutschland GmbH,
Latschbacher GmbH & Co. KG

Title: **Real-time forecasting of the behaviour of seismic waves on the base of stochastic models and Fuzzy logic**

Financial Support: NATO, PST.CLG.979333

Grant: 11.000 EUR (travelling expenses)

Approach: The objective of the project is to determine the parameters of a wave-based non-stationary strong motion model from basic seismic information and the recorded parts of the seismic records. Best fitting records have to be identified from databases of worldwide strong motion records on the bases of the model. Another task is modelling of the bedrock and soil layers. On the base of classifications of bedrock and soil layer frequency models of soil layers can be developed. During the investigation it is envisaged to develop an intelligent hybrid model which can forecast in real-time the behaviour of strong motion records on the bases of general, tectonic, seismic and site parameters. This hybrid model will be based on seismic wave theory, data analysis, stochastic modelling, classification methods, fuzzy theory and neural networks. The real-time forecasting of strong motion records is an important precondition for application in structural control in order to protect structures against destructive waves during an earthquake.

Partners: University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria, University of Rousse, Bulgaria.

Lecture Activities 2005

Title: Computer-Aided Design and Drafting

Intended Audience: 1st semester, students of civil engineering
Lectures and Tutorials: Scherer/Böttcher
Subjects: This course provides background knowledge of the methodology and techniques of computer-aided design. Basic CAD 2D and 3D functionality is presented as well as advanced methods for the efficient application of CAD technology in civil engineering design, such as data structuring techniques (layers, blocks, symbol libraries), data exchange paradigms and formats (DXF, STEP, IFC), user interface and output facilities. The general features of CAD systems are presented on the example of ALLPLAN/ALLPLOT. Attention is given also to specialised systems for building design with examples from the field of reinforcement detailing.

Title: Computer-Aided Solutions of Engineering Problems

Intended Audience: 2nd semester, students of civil engineering
Lectures and Tutorials: Scherer/Gerk
Subjects: The systematic analysis, synthesis and implementation of software solutions for engineering problems are presented. Focus is on numerical engineering problems. The use and benefit of a formal graphical representation language using the structogram method is demonstrated. Special emphasis is given to distinguishing between the topological, geometrical and the visualization model. The practical tutorials aim at writing and testing structured programs in the programming language C++.

Title: Data structures and data bases

Intended Audience: 3rd semester, students of civil engineering
Lectures and Tutorials: Scherer/Gerk
Subjects: Introduction to abstract data types, sets, relations, objects and classes. Classification in linear data types, partitions, graphs and associations. Definition of equivalence relationship and introduction to relational data structures and corresponding basis operations. Presentation of the corresponding support of C++ for objects, classes, methods, inheritance and operators. The Tutorials practise these methods and algorithms in the programming language C++.

Title: Numerical Mathematics

Intended Audience: 4th semester, students of civil engineering
Lectures and Tutorials: Hauptenbuchner
Subject: This lecture informs on, and consolidates methods of numerical mathematics being used in CAD and CAE-software. After a general introduction to the methods of numerical mathematics, algorithms of solution for linear systems of equations, esp. the Cholesky method, and algorithms of solution for large band-structured matrices are introduced; this is followed by a survey of algorithms of solutions for eigenvalue problems. Graphical representation of results from numerical methods, which are available in discrete form, is realized by interpolation methods, esp. SLINE-methods.

Title: Relational data structures and systems data management

Intended Audience: 5th semester, students of civil engineering
Lectures and Tutorials: Scherer/Gerk
Subjects: First, an introduction to data management and data bases is given and hierarchical and relational data structures are shortly opposed. The requirements of engineering applications like very long term transactions are summarized and opposed to other applications. The basics of relational data structuring like entities, relations and association types, cardinality, key attributes, transformation of relations, redundancy, recursive relations, generalization, specialization are presented. The bottom-up procedure of a data base design using the normalization approach is shown. Basics of SQL are introduced. Tutorials are carried out applying ORACLE software.

Title: Computer-Aided Engineering: Applications for Structural Engineering

Intended Audience: 6th semester, students of civil engineering
Lectures and Tutorials: Scherer/Wagner
Subjects: Introduction in object modelling, EXPRESS and EXPRESS-G representation techniques and STEP physical file format. A simplified IFC compliant model for the structural system modelling and analysis is outlined. Basic principles and techniques for the effective use of numerical analysis programs in the solution of various structural design tasks are introduced. An insight into the methods for correct modelling of engineering problems as well as for the appropriate structuring of the necessary information and the proper interpretation of analysis results is given. Special emphasis is put on the formulation of FEM analysis tasks in terms of the entity relationship modelling approach. Examples include the modelling and solution of typical FEM problems, such as stress-strain analysis of slabs and shear walls subject to various kinds of loads applying the CAD/CAE tool Nemetschek Allplan.

Title: Software Engineering

Intended Audience: 7th semester, students of civil engineering and of ITC-Euromaster course
Lectures and Tutorials: Menzel
Subject: The course aims on combining the special knowledge in the fields of Databases, Information Modelling, and the development of CAE-solutions. It furthermore integrates aspects of “E-business and E-commerce”. The main objective of the course is the presentation of knowledge about the different “software life-cycle models”. Civil Engineering students learn how to perform a requirements elicitation, how to analyse a domain model and how to transfer a domain model into a complete system model in co-operation with IT-specialists using standardized methods and notations such as UML.
Furthermore, the students learn how to initiate and manage large interdisciplinary teams and how to moderate negotiations between clients, users, IT-managers and developers.
Within the project the students work in groups on the design, development and prototypical implementation of a complete software system.

Title: Object-Oriented Modelling - Fundamentals and Application in Structural Engineering

Intended Audience: 8th semester, students of civil engineering, track structural engineering
Lectures and Tutorials: Scherer/Katranuschkov
Subject: This course aims at giving civil engineering students an understanding of the basic principles and the practical application of the object-oriented modelling methodology as a powerful vehicle for the design and realisation of complex computer-aided engineering tasks. Special emphasis is put on the discussion of advanced product data technology methods based on the international standard STEP and the industry standard IFC of the IAI. The students are actively involved in modelling tasks selected from everyday engineering practice with focus on the adequate formal specification of structural design problems and the respective product data representation and product data exchange specification.

Title: eBusiness & Data Warehouses in A/E/C and FM

Intended Audience: 8th semester, students of civil engineering and ITC-Euromaster course
Lectures and Tutorials: Menzel

Subject: Within this course students will get a broad understanding of e-business in AEC and Facilities Management. Firstly, the different types of "eBusiness" are explained in general. Secondly the students gain detailed knowledge about methods of Business Process Modelling (BPM). Furthermore, the students acquire fundamental knowledge about basic IT-methods and technologies supporting eCommerce. The major focus is on multi-dimensional data management. Finally, the students will get an overview about technical aspects of data security and billing systems. Within seminars the students learn how to implement a project using ROLAP technology.

Title: Artificial Intelligence Methods and Their Application in Structural Engineering

Intended audience: 9th semester, students of civil engineering, track structural engineering
Lectures and Tutorials: Scherer/Katranuschkov

Subject: This course of lectures aims at introducing methods of Artificial Intelligence (AI) to engineers related to specific problems of their daily practice, especially with regard to design, processing of standards and team work. The students gain an understanding that computer support is not restricted to numerical computation, as e.g. programs for structural analysis or CAD, but can also involve manipulation of symbols thereby providing "intelligent" behaviour. The lecture is intended to introduce AI as underlying technology for advanced programs that might influence the way engineers will do their design in the future.

Title: Mobile Computing

Intended Audience: 7th semester, students of civil engineering and of ITC-Euromaster course
Lectures and Tutorials: Menzel/Prof. Rebolj, University of Maribor

Subject: The purpose of the subject is to understand the potentials and the importance of mobile computing in construction, to learn about underlying technologies of mobile computing and the ways of using it in construction projects, especially in the building phase. An essential part of the subject is to gain experiences with introducing and applying mobile computing in the field. The intended learning outcomes are: in depth understanding of the basic technologies and potentials of mobile computing. Furthermore the participants will analyse and specify usage scenarios for mobile computing technologies in the AEC or FM-sector.

Title: Construction Information Management

Intended Audience: 9th semester, students of civil engineering, track structural engineering
Lectures and Tutorials: Scherer/Katranuschkov

Subject: The effective management of design, construction and facility management information throughout the whole life cycle of a building is a task with strategic importance for the competitiveness of the building industry. This course discusses basic information management techniques used in current engineering practice (structuring of CAD information, data exchange paradigms, workflow management, team collaboration), as well as emerging new software methods and techniques, especially with regard to the World Wide Web. On the basis of typical co-operative engineering scenarios, advanced information management methods like Internet-based communication, product, process and document modelling and information sharing are discussed. Emphasis is given to the organisation of concurrent engineering work.

Title: Risk management

Intended Audience: 8th semester, students of civil engineering
Lectures and Tutorials: Scherer/Bretschneider, Faschingbauer
Subjects: The basic principles of risk and probability theories are explained. The risk management cycle is outlined and the possible interactions, demands and improvements are indicated. A clear distinction between planning and preparing cycles and crisis management will be made. Information flows will be shown and the basic methods for the information management will be demonstrated. Case studies will be done for earthquake engineering risk management.

Title: Building history (read in English)

Intended Audience: 1st semester, Master programme in rehabilitation engineering
Lectures and Tutorials: Scherer (co-ordination), Curbach, Haller, Herle, Herz, Pohl
Subjects: This course offers a short outline of essential aspects in building history covering the historical development of building technology from medieval times to present. Furthermore the correspondence between social conditions of living and working, the development of urban and suburban areas, the demands on engineering solutions, the development of engineering science and the institutionalisation of engineering education with its feedback to new solution capabilities are outlined. Each lecture of the course is a self contained unit dealing with a special subject showing the development of technology and engineering on best practice examples.
The lectures are Historical Framework (Scherer), Geotechnical Engineering History (Herle), Timber Building History (Haller), Hydraulic Engineering History (Pohl), Bridge Engineering History (Curbach), Structural Engineering History (Scherer), Dresden Baroque (Herz).

Title: Management information systems

Intended Audience: 2nd semester, Master programme in rehabilitation engineering
Lectures and Tutorials: Scherer/Katranuschkov
Subjects: The first part of the module covers methods for object-oriented modelling of complex engineering systems. Further course material focuses on communication methods and formal representation of communication goals, which allow the efficient application of automatic evaluation and decision support methods and –algorithms. The third focus is placed on control methods and develops a methodology for performance measurement.

Title: Information mining

Intended Audience: 2nd semester, Master programme in rehabilitation engineering
Lectures and Tutorials: Scherer/Katranuschkov
Subjects: This course introduces methods for data analysis and data mining, e.g. correlation and regression, classification, decision trees and clustering. Their application aims at the early detection of damages and faulty system behaviour. The scope of their application and how they are complemented are discussed. An additional part of the lecture covers data pre-processing since the efficiency of the methods strongly depends on the modelled data. The inter-dependencies of the methods for modelling and data structures are explicated.

Title: GIS for infrastructure systems

Intended Audience: 2nd semester, Master programme in rehabilitation engineering
Lectures and Tutorials: Scherer/Katranuschkov

Subjects: This course gives an introduction into graph theory, by which the partitioning and the formal area-related variables dependencies can be described. The mapping from object-oriented data models to area-related representations and the generation of area boundaries by means of data mining methods are discussed. Different ways of graphical representation for complex, multi-layered information in terms of area magnitude are introduced. The lecture deduces and accounts for preferred modelling and data analysis techniques for corresponding graphical representation methods.

Title: Informatics in civil engineering

Intended Audience: 6th semester, students of science of the economy
Lectures and Tutorials: Hauptenbuchner
Subjects: This lecture aims at giving an introduction to the specific problems of software in civil engineering, the special requirement to the hardware, the way of work with the software and the future trends. Especially the area of the functionality of CAD- and CAE software will be discussed. The students get a survey of the software used in civil engineering offices and can acquire knowledge that allows them to judge such software products concerning quality and performance. A further aim is to enable the students to assess the expenditures on installation of new software, training of staff to operate it and carrying out of projects by appropriate software products.

Title: Informatics in architecture

Intended Audiences: 1st semester, students of architecture
Lectures and Tutorials: Hauptenbuchner
Subjects: The course shall allow the students to acquire knowledge of and proficiency in computerized data processing that will enable them to prepare multi-media documents of up-to-date quality. This requires experienced skills in using operating systems, text and graphic processing software, calculation programs and data bases as well as interfaces between them. Because of their wide-spread use Microsoft Office products are particularly presented. A performance test after the course shall prove the knowledge of and proficiency in the usage of Microsoft Office products incl. of interfaces provided to prepare a document of a subject chosen at liberty but according to well defined criteria.

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[3] SCHERER R.J., KATRANUSCHKOV P.: Management of Mulit-Dimensional Project Information Space, Tamer El Daraby (ed.), Proceedings of the CIB-W78 workshop, Toronto, May 2004.

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[9] WEISE M., KATRANUSCHKOV P., SCHERER R.J.: Generic Services for the Support of Evolving Building Model Data, ISBN 3-86068-213-X (abstracts), Proceedings (CD-ROM) of the Xth International Conference on Computing in Civil and Building Engineering – ICCCBE, paper no. 016, Weimar, Germany, June 2004.

[10] EISENBLÄTTER K., MENZEL K., SCHERER R.J.: About the Implantation Process of Mobile Computing in AEC, ISBN 3-86068-213-X (abstracts), Proceedings (CD-ROM) of the Xth International Conference on Computing in Civil and Building Engineering – ICCCBE, paper no. 161, Weimar, Germany, June 2004.

[11] MENZEL K., WAGNER U., KELLER M., ANTONIADIS G., CAIRES BRANCO A.: Resource Management for the Construction Industry, ISBN 3-86068-.213-X (abstracts), Proceedings (CD-ROM) of the Xth International Conference on Computing in Civil and Building Engineering – ICCCBE, paper no. 162, Weimar, Germany, June 2004.

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Editorial Boards Positions

Advanced Engineering Informatics	Elsevier Publishers	The Netherlands
Information Technology in Architecture, Engineering and Construction	Millpress Publisher	Great Britain
Information Technology in Construction (electronic journal)	TH Stockholm	Sweden
Construction Innovation	Arnold Journals Publisher	Great Britain

Membership in standardization groups

DIN GA-CALS	German CALS committee (integrated information flow and process flow)	Vice chairman
DIN Dok-Bau	Standardization committee for technical product documentation in civil engineering	Vice chairman
DIN NAM 96.4.1-3	Product data exchange in civil engineering	Vice chairman
ISO 10303/BC	Standard Exchange of Product Data, work group Building Construction	Member
IAI	International Alliance of Interoperability (product modelling in civil engineering)	Member
IAI/ST-4	ST-4 Structural Model	Vice chairman