TECHNISCHE UNIVERSITÄT DRESDEN

INSTITUT FÜR BAUINFORMATIK

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RESEARCH AND LECTURE ACTIVITIES IN 2009

December 2008

Institute of Construction Informatics

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Research at the ”Institute of Construction Informatics – Bauinformatik” (CiB) is in two directions:

Applied Informatics and ***Applied Stochastics***

The view of the brochure is directed to the future, i.e. to new ideas and what is planned to be done by each research assistant and PhD student in 2009, based on the results achieved in 2008. Current research topics are: (1) building information models, (2) intelligent engineering structures and construction methods, (3) virtual organizations, (4) project risk and simulation management, (5) dynamic process modelling and (6) e-learning. Main basic methods applied are object-oriented methods, engineering and business ontologies, description logic, agent methods, service-oriented architectures, grid computing, fuzzy logic and information mining.

The institute has been very active in the field of ICT in construction management and geotechnical engineering so that two larger proposals with 12 (MEFISTO) and 6 (GeoIngGrid) partners, have been co-ordinated, which successfully passed step 1. Both these projects would interlink several of the research fields described in this report.

The institute strongly promotes IT in research and industry. Prof. Scherer is chairman of the European Association of Product and Process Modelling, which will hold its 8th ECPPM conference at the University College Cork, Ireland in September 2010. In early September 2008, the conference again brought together leading European academic and industrial researchers and developers in construction IT and IAI working groups in Nice, France (*http://www.ecppm.org*).

In late September 2008, the institute hosted the 20th annual German-speaking conference on construction informatics “Forum Bauinformatik” (see *http://www.forum-bauinformatik.de/*). This conference is dedicated to young researchers and has developed to a lively forum of exchanging ideas among the research staff of German-speaking institutes of construction informatics in D-A-CH. We gratefully thank the generous sponsors Nemetschek, München, RIB, Stuttgart and BAM Deutschland, Dresden.

Know-how transfer to the industry has a high priority for the institute to facilitate practical exploitation of developed innovative IT solutions. For the industry CiB is a National Information Point in construction IT. CiB is active in international and national standardization bodies in the domains of IT-related product, process, and document modelling and holds chair and vice-chairman positions there.

In 2008, the “Dresdner Bauinformatik-Gesprächskreis” (Dresden Construction Informatics Dialogue) was silent but will be reactivated in 2009. Presentations available at *http://cib.bau.tu-dresden.de/ddbig*.

E-learning activities have been continued with an innovative interactive distance-learning tool for object-oriented modelling, programming and software engineering. The chosen application environment is construction site simulation. The European on-line master course “IT in Construction”, co-ordinated by the University of Maribor, Slovenia, is in its 5th academic year and can be chosen at 7 European universities. CiB’s contributions are lectures in “Data Mining”, “Software Engineering” and “Management Information Systems”. New lectures on beneficial applications of ICT to improve energy efficiency of buildings are constituted resulting from the REEB project and the request for a new course of studies on Building-Energy-Management to be offered from the department starting in October 2009.

Collaborative research was reinforced through intensive information exchange with external scientists. In 2008, we were glad to host Prof. Attila Dikbas (Istanbul Technical University, Turkey), Prof. Karsten Menzel (University College Cork, Ireland) and Prof. Svetla Radeva (University of Sofia, Bulgaria).

In July, Umut Gökce successfully defended his PhD and left for a post-doc at the University College Cork, Ireland. Faisal Shaukat left the institute in July to start his career in industry at a software company in Berlin and in September, Jalal Dabagh left for his home country, Syria. In April, Tatiana Suarez joined the institute as a research assistant working on the REEB project on ICT use for improvement of energy efficiency of buildings. In July, Sebastian Fuchs, a civil engineer, strengthened our institute as an external PhD student. In August, Alexander Wülfing, a student of informatics, joined the BauVOGrid group by contributing with his first part of his master thesis. In September, Frank Hilbert, a computer scientist, joined our BauVOGrid group as research assistant, thus strengthening our knowledge on distributed systems and Grid technology. In October, Yaseen Srewil decided to continue his successful master study as a PhD student in earthquake engineering.

Some further information can be found at our web pages *http://cib.bau.tu-dresden.de*

Dresden, in December 2008 Raimar J. Scherer

Research Contracts

Title: **BauVOGrid – a Grid-based platform for virtual organisations in construction** *(BauVOGrid – Grid-basierte Plattform für die Virtuelle Organisation im Bauwesen)*

Project Leader: Dr.-Ing. Peter Katranuschkov

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

Budget: 2,406,000 Euro (total), 396,000 Euro (CIB, TU Dresden), Duration: 3 years

Approach: Main motivation is the fact that in construction practice VOs typically include dozens of subcontractors and are characterised by highly complex partner interrelationships distribution of work and responsibilities are intransparent and error-prone, often leading to considerable time and cost loss. A Grid-based platform is going to be developed that enables (1) the formal computer-interpretable representation of authorisation, access control and responsibility structures, (2) the configuration, instantiation and management of both global VO-processes and local partner-internal activities, as well as ad-hoc changes in the project workflow, and (3) flexible access to all kinds of information services both in the office and mobile, at the construction site. The envisaged infrastructure will be achieved by innovative integration of four cutting-edge information technologies, i.e. (1) Grid, (2) Semantic Web, (3) Process modelling and management based on object-oriented eEPCs, and (4) mobile gird-based information and workflow management. The BauVOGrid project contributes to the improvement of VO structuring and operability through an innovative Grid-based VO environment that builds upon developments within the German D-Grid initiative as well as prior work of several project partners in earlier or running EU projects such as InteliGrid, K-Wf Grid , AKOGRIMO.

Partners: Fraunhofer-Institut für Rechnerarchitektur und Softwaretechnik (Berlin), Institut für Wirtschaftsinformatik im DFKI (Saarbrücken), IDS Scheer AG (Saarbrücken), conject AG (München), Bilfinger Berger AG (Mannheim), Müller-Altvatter Bauunternehmung GmbH & Co. KG, Niederlassung Dresden, RIB Information Technologies AG (Stuttgart), Bundesverband Bausoftware e.V.

Title: **REEB – The European strategic Research Roadmap to ICT enabled Energy-Efficient in Buildings and construction**

Project Leader: Prof. Dr.-Ing. R. J. Scherer

Financial Support: EU – EC FP7, Theme 3 "Information & Communication Technologies – ICT for Environmental Management & Energy Efficiency

Budget: 1,259,000 Euro (total), 132,000 Euro (CIB, TU Dresden), Duration: 2 years

Approach: The aim of the REEB project is to facilitate co-creation of a Strategic Research Agenda (SRA) and a supporting Implementation Activity Plan (IAP) for sustainable and energy-efficient smart building constructions by and through the establishment of and federation of dialogue between interactive and complimentary communities of practice from energy, environment, and building construction domains. REEB will establish a community operating method that will allow these communities to act as breeding and nurturing grounds for innovation in bringing together the relevant organisations and stakeholders for the purpose of starting up "innovation cycles in ICT-based environment management and energy efficiency" in smart building constructions. The main outcomes will be (i) a SRA and detailed IAP for R&D and innovation in ICT supporting energy-efficient smart facilities, (ii) a comprehensive coordination of information exchange and dissemination between energy-related ICT projects in various EU, national, and global programs/initiatives, in terms of on-going research, developed solutions, standardisation efforts, etc.. This will include organising events and communication channels for identifying, defining, promoting and stimulating the innovative use of ICT in the Sustainability and Energy Efficiency area to reach the widest audience and bring together all stakeholders from the enlarged EU and relevant global communities. The REEB consortium involves 8 partners with complementary expertise drawn from 6 European countries (France, Finland, Spain, Ireland, UK, Germany). Moreover, the core partners, in their effort to

build up the REEB community and develop the vision, roadmap and implementation plan, are supported by this Special Interest Group (SIG) whose members (both RTD and industry) will participate in community discussions and decisions, and provide active feedback to studies and analyses.

Partners: Centre Scientifique et Technique du Bâtiment (France), Technical Research Centre of Finland (Finland), Commissariat a l'Energie Atomique France), Fundación LABEIN (Spain), Acciona Infraestructuras (Spain) , Ove Arup & Partners international Limited (UK), University College Cork (Ireland)

Title: **Product Data Management Services in Distributed Co-operative Design Environments** *(Produktdatenmanagementdienste in verteilten Umgebungen für das kooperative Planen)*

Project Leader: Dr.-Ing. Peter Katranuschkov

Financial Support: DFG (German research foundation), Sche223/36-1

Person Years: 2, Duration: 2 years

Approach: The objective of the project is to develop methods and tools to extend existing document management systems to include full product server functionality. This will be achieved on the basis of the Service Oriented Paradigm (SOA). Generic product data management methods for model mapping, matching, re-integration and versioning, initially developed in an earlier DFG-Project (Sche 223-27/3 within SPP 1103), will be further extended, adapted to practical use cases, implemented as self-contained Web Services and integrated in a distributed environment with a proprietary file-based information management project portal. This will enable the interoperable, use of (1) various existing administrative portal services, such as organisation and user management, document management, notification/messaging etc. and (2) the set of innovative product data management services within a coherent environment, without the need to maintain a separately managed Product Model Server. A specific research focus of the project lies on the development of product data management methods for long engineering transactions without data locks. These methods will be implemented in scalable robust algorithms, adapted to the IFC Project Model and deployed as dedicated Web Services within the overall production environment.

Partners: conject AG (München), Obermeyer Planen + Beraten (München).

Title: **"Campus-Navigator"** – The guidance system of the TU Dresden

Project Leader: Dr.-Ing. Uwe Reuter

Financial Support: TU Dresden

Duration: Since 2001

Approach: Room-related digital data of buildings belonging to the TU Dresden campus are collected by the administration of the TU Dresden. The Campus-Navigator summarizes these data as an externally working system and provides employees, students and visitors these data in a textual and graphical way on an interactive website. All relevant information stored in university's CAFM-system KOPERNIKUS, using an ORACLE database, can be accessed that way. The software visualizes floor and orientation plans in real time out of this data by transforming them into vector graphics in the SVG format, which finally can be displayed in browsers, for instance via the ADOBE SVG plug-in. Linking and visualizing of the graphical and textual data is based on XML. Via a self-managed ORACLE database especially created HTML pages for disabled persons are integrated. Besides the automatic synchronization with the administration databases the content of the curriculum timetables is also provided. With special attention to disabled or mobility restricted persons a routing system (routing through the campus) based on the A-star-algorithm has been developed, which is supported by a parsing process that augments the existing CAD-data with necessary semantics. Advantage of this system is the collection of information from a diversity of data sources, their transformation, graphical rendering and especially the deployment in existing and established networks and end-user environments.

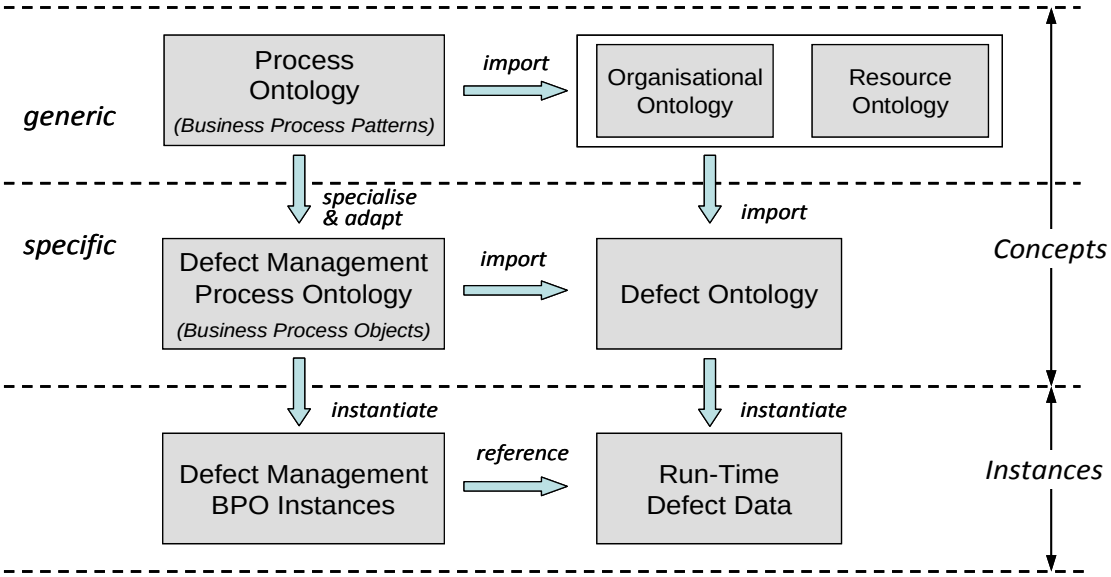
Title:	**Appraisal of Methods and Criteria for Sensitivity Analysis at Non-linear Structural Behaviour**
Project Leader:	Dr.-Ing. Uwe Reuter
Financial Support:	DYNAmore GmbH
Person Years:	Since 11/2007
Approach:	Structures are described by structural parameters, e.g. for material behaviour. Structural behaviour under live load is simulated by computational models. Structural responses are thus assigned to structural parameters. Structural parameters are subject to random variations, which can be described by probabilistic models. The property randomness of the structural parameters yields random structural responses. Investigation of the influence of fluctuating structural parameters to structural responses is called sensitivity analysis. A lot of established methods on the basis of linear correlation models and criteria exist for sensitivity analysis of (approximately) linear structural behaviour. If there is a non-linear interrelationship between structural parameters and structural responses these methods are improper. Actual developments for appraisal of sensitivity of non-linear interrelationships are auspicious. Within the framework of this project methods and criteria for sensitivity analysis at non-linear structural behaviour have to be appraised and implemented with the aid of a proper programming language.

Ontology-based Collaborative Defect Management

Peter Katranuschkov, Ksenia Rybenko

Objectives

This research aims at improving the operability of complex concurrent processes in AEC. The selected target application area is defect management where highly distributed information resources and many inter-related processes of multiple participants are typical. The research hypothesis is that a harmonised ontology knowledge base representing processes but also the actors, resources and services involved in these processes can provide a collaboration model with clear and unambiguous semantics, thereby facilitating integration and reuse of existing process and data models for defect management. Modelling of the construction processes can be done at the outset using ARIS methodology, and event-driven process chains (EPC) in particular. However, EPCs lack fully formalised mechanisms that can enable flow control together with proper resource assignment to processes and explicitly defined actors/roles with respective process-related responsibilities and access rights. Therefore, a formal description of the overall model realised by a set of inter-related ontologies is needed. This provides for an expedient mechanism for the achievement of interoperability in complex systems with multiple heterogeneous resources.



Representation levels and their principal interdependencies in the system of ontologies for defect management

Approach

The developed layered set of inter-related ontologies provides a clear distinction between concepts and instances as well as between generic and specific concepts in the knowledge base. Consequently, knowledge representation of the process is done in three steps, from generic (meta) concepts, representing business process patterns, through specific domain concepts to executable business process objects (BPO). A *Process ontology* describes the main features of abstracted EPCs, which can be used in any process management environment. This high-level EPC model is translated into an OWL-based ontology which is then linked with existing *Resource* and *Organisational ontologies*, using the ARIS methodology as baseline. The *Defect Management Process Ontology* on the next level is a specialisation of the generic Process ontology. It describes the defect management process, thereby reflecting an idealised defect management EPC. The ontology contains the description of business process object classes, which are then used to define executable business process instances that provide the main building blocks in the knowledge base at runtime. The criteria for identification and specification of BPO classes are process semantics, abstraction, configurability, responsibility and time. The *Defect ontology*, on the other side, describes the harmonised defect management data, originally contained in multiple proprietary databases of the project participants. This ontology plays a mediator role, enabling harmonised data access and sharing.

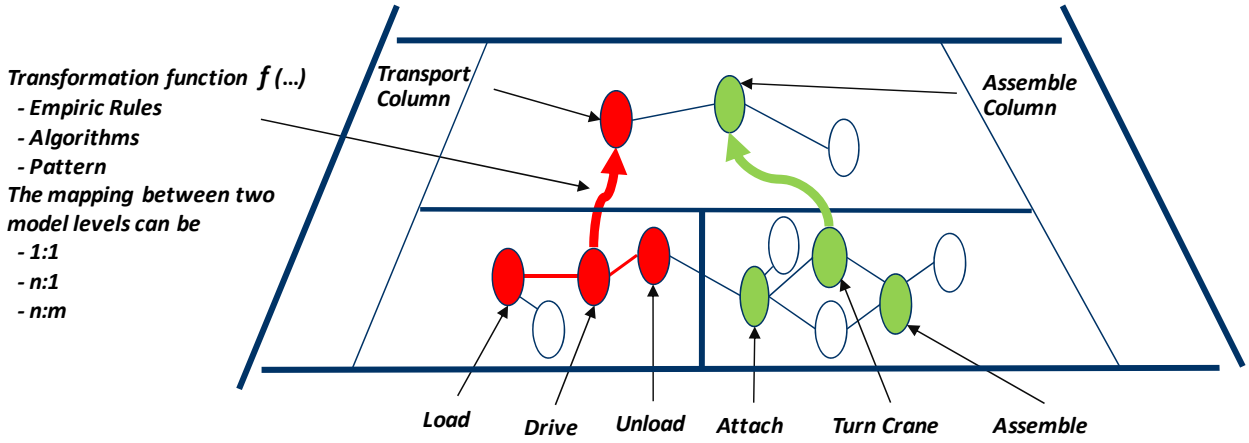
At run-time in a large project several 10,000 defect management EPCs need to be instantiated and processed in parallel. The developed approach based on the described system of ontologies and reflecting all parts of the process and the applied data, enables achievement of comprehensive process-centred operability and hence more efficient and transparent collaborative work processes.

Creating Hierarchical Simulation Models for Construction Processes

Ulf Wagner

Objectives

Simulation of the complex production processes at the construction site is rarely done today. This is partly due to the lack of appropriate simulation tools but much more to the lack of time to prepare adequate simulation models and data on the site. Creation of a simulation model over a long time (several days or even weeks) is not practical and therefore of little help. Hence, reduction of data collection and efficient model preparation times are of primary concern. To tackle such issues, simulations should be modelled on the highest possible level of abstraction but carried out at appropriate detail levels. What is needed are therefore vertical model transitions based on key performance indicators that characterise in compressed form the features of objects on the more detailed levels. Using such vertical transitions simulation models can be efficiently created both bottom-up (starting with specific known site elements and processes and generalising these as necessary) or top-down (from a generalised high-level view to specific simulation data). As an example, the simulation of column assembly can be considered. In a first step, transporting the prefabricated column elements with one or more trucks can be analysed, and in parallel, assembly of these elements using a crane. By combining these simple activities, a more complex task called “deliver and assemble columns” can be abstracted, using key indicators for the required performance. Vertical transition methods should make such a hierarchical simulation modelling possible.



Schematic presentation of bottom-up model transitions between two levels of abstraction

Approach

A cornerstone of the suggested approach is the adequate use of *key performance indicators* (KPI) and related information representation elements. The properties of objects represented on one modelling level are described by such KPIs which provide for the necessary information compression. An object on the lower level can be represented as a single KPI value on the higher level, or multiple objects belonging to more than one submodel can converge to a single object described by multiple KPIs. The knowledge how this is done (algorithms, rules, data) is stored in a knowledge base so that it can be later re-used both in *compression* (bottom-up) and in *expansion* (top-down) transitions. Additionally, *relationship objects* describing the inter-model links on class level are created and stored. Such links can have 1:1 but also n:1 or n:m cardinality.

Compression methods for various project data (BIM elements, processes, costs, resources) should enable flexible grouping of objects on a lower level to respective objects or even single attributes on the higher level. For that purpose, basic methods from the area of multidatabase research are used (e.g. meet, fold, telescope, combine). Additionally, the use of uncertainties (via fuzzy values) needs to be taken into account.

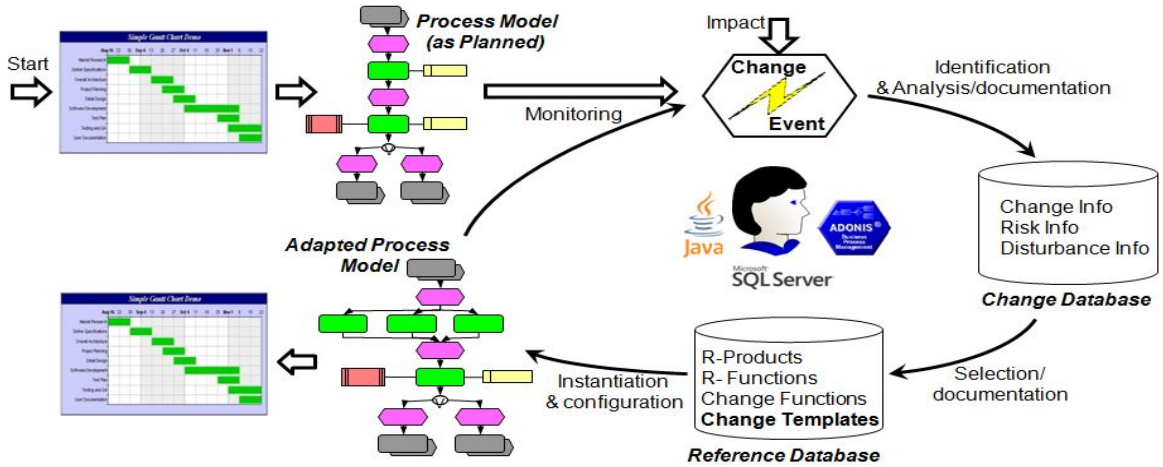
Expansion methods have the goal to propagate changes undertaken by decision-makers on a high abstraction level to the lower modelling levels to enable early detailed simulation and verification of decisions. However, as the process of compression inevitably leads to information loss, expansion methods are not simply the inverse of the compression methods. Rather, logical validity and engineering rules and constraints need to be extracted and applied, using the stored in the knowledge base generic relationship objects. To achieve that, planning and configuration methods from the area of AI will be applied.

Adaptive Construction Management Plans Using Process Templates

Wael Sharmak

Objectives

Construction industry is project-based. Each project is a temporary alliance between autonomous partners. These partners have different objectives, techniques, project-perspectives. This, amongst others, makes the uncertainties faced in construction bigger than other industries. Consequently, no construction project ever goes totally as planned. Furthermore, it is common to face time and cost overruns infracting the contractual baselines. Such overruns are caused by various factors which impact one or more of the project management plans and cause changes in the project. Some change factors are impossible to be identified in advance, e.g. human errors. Such events may occur suddenly and cause changes after execution start, i.e. in the project's post-fixity stage. Therefore, there is a need to react effectively and efficiently to these events using appropriate procedures. The proactive and reactive actions can change, for example, the project schedule in different ways. New activities may be added between/in parallel to old planned one, planned activities may be canceled or substituted or even their parameters may be modified.



Adaptive Project Plan Life-Cycle

Approach

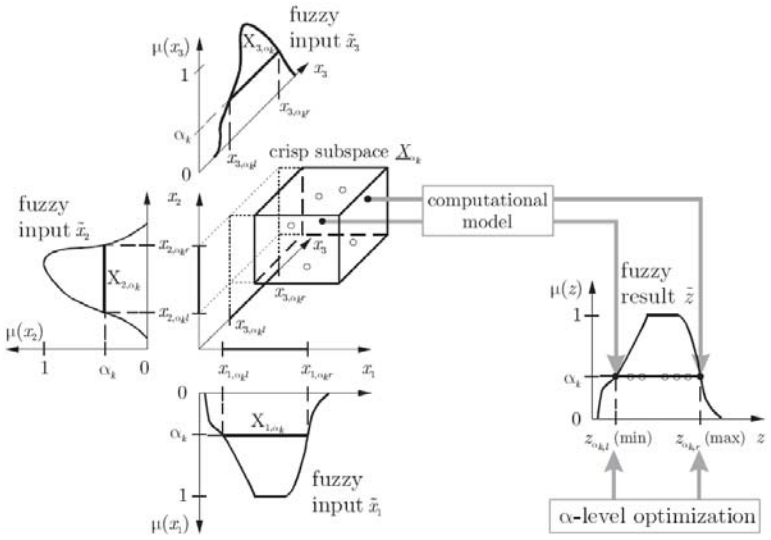
The Event-driven Process Chains method (EPC) will be used to model project schedule plan as it is an event-driven method. Therefore, a change can be represented as a deviation event in the process model. As well as, EPC supports configurable modeling. This is needed to model uncertainty in the project. Change types in project schedule structure will be developed as process model templates using normal and configurable EPC elements. This will result in a few generic change templates; each template describes a way of structure change within the project schedule. Accordingly, a referential (ChangeFunction - ChangeTemplate) link can be assigned within an available/new-established reference databases. By linking a type of templates to each change action an automatic simulation can be implemented to show the adapted plan scenario. This can include changes in the tasks themselves, in their parameters, or in their dependencies. The whole approach can be described as a repetitive planning cycle. If new change factors will be monitored within the project span, the change should be identified and analyzed based on the available information in the *Change Database*. Such analysis can verify the feasibility and necessity of making this change. In view of that, a suitable change function will be selected from the *Reference Database*. The adaption structure of this function in the process model is based on one of the developed change templates. This will enable automatic configuration of the process model to be adjusted to the new situation. This cycle may be repeated several times within the project lifecycle as new changes appear to the surface. The mentioned databases will be designed as relational databases using SQL. The process models will be created using ADOINS® business modeling tool, which is based as well on an SQL server database. A JAVA prototype will connect the process modeling tool to the databases to pass needed data and adapt the schedule plan "the process model". This approach will enable as well performing *What-If* scenarios for simulation purposes.

Application of Fuzzy Analysis in Operational Construction Management and Organisation

Uwe Reuter

Objectives

The intended research is aimed at application of mathematical methods for fuzzy analysis in operational construction management and organisation. Fuzzy analysis maps uncertain input data in the form of fuzzy variables onto fuzzy result variables. The operator of the mapping can be any desired deterministic algorithm, in this case simulation of construction processes. Construction processes are influenced by various factors. The influencing factors are decisively affected by uncertain constraints. Software solutions in the field of operational construction management and organisation mainly focuses on simulation of construction processes neglecting those uncertain constraints and using deterministic key performance indicators. An efficient realistic numerical simulation depends on the quality and complexity of computational models and methods as well as the reliability of available input data. Consideration of these uncertain constraints in numerical simulation requires adequate computational models for processing uncertain data.



Fuzzy analysis with a-level optimization

Approach

Fuzzy analysis is an appropriate computational model for processing uncertain data using the uncertainty model fuzziness. Fuzziness is an uncertainty model that takes into account impreciseness of data. Basic terms and definitions related to fuzzy analysis have been introduced, iter alia, by Möller et al, 2000. A suitable form of representation of fuzzy variables with the scope of numerical simulation problems is given with the so-called α-discretization. Fuzzy analysis is described by

$$\underline{\tilde{z}} = (\tilde{z}_1,\ \tilde{z}_2,\ ...,\ \tilde{z}_m) = \tilde{f}(\tilde{x}_1,\ \tilde{x}_2,\ ...,\ \tilde{x}_l).$$

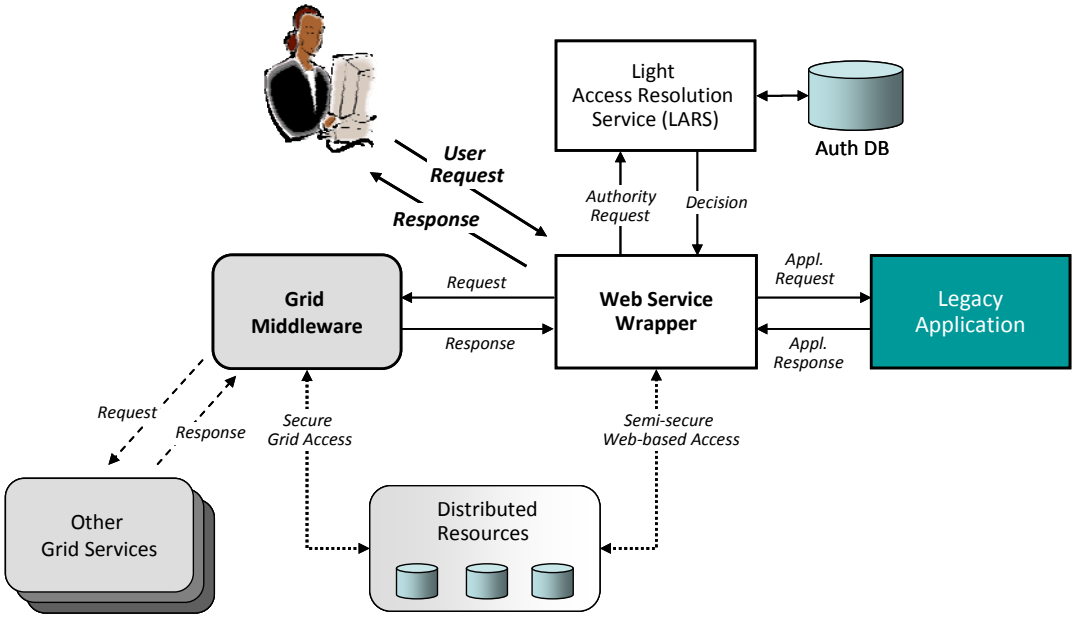
That equation defines the mapping of the fuzzy input variables onto the fuzzy result variables. The mapping model represents the computational model of the fuzzy analysis. Thereby, the computational model exploits the discretization of the convex fuzzy input variables and convex fuzzy result values into α-level-sets. All fuzzy input variables and fuzzy result variables are discretized using the same number of α-levels. In the case of convex fuzzy input variables the fuzzy result variables are completely described by solving the α-level optimization problem.

A Minimal Approach for Plugging-in Legacy Applications into Web and Grid Environments

Frank Hilbert, Peter Katranuschkov

Objectives

A major reason for the reserved acceptance of Grid Computing in the AEC industry is the considerable effort needed to manually re-engineer existing legacy applications that were not initially designed to run on Grid. For various reasons, such as license limitations, application dependency on special libraries, optimization for a specific platform, lack of (or limited) modularity etc., most such applications cannot be easily converted to Grid-Services. Therefore it is necessary to develop a structured approach to make such applications available on a Grid environment with as little effort as possible, while leaving their code virtually untouched. Furthermore, to allow for use of the applications in different environments it is necessary to engineer the solution approach in such way, that both web service and grid service access is possible. This requirement leads to the need of specific consideration of security and role-based access control.



Generic Approach to plug-in a legacy application to a Web or Grid-Environment (white boxes denote services on the web space, grey boxes services on the Grid)

Approach

The developed approach is based on the concept of *service wrappers*. This leaves the application essentially as backend outside the Grid, while connecting it to all other components of the environment via a Web Service Wrapper (WSW). The wrapper is composed of a generic, reusable module and a specific module dedicated to the actual application bindings. Using an ontology for organisational and role concepts together with a Light Access Resolution Service (LARS) and an Authorisation Database enables to flexibly plug-in the application in a distributed web-based platform. Communication between the application and its Web Service Wrapper is achieved via SOAP messages, using XML schema for data representation and HTTP for transport. In this strategy, it is important that the legacy application provides access to its functions via SOAP. However, this is available for most applications used in industry practice today. Integrating the WSW into a Grid environment as shown in the above figure makes it possible to gain full access to Grid middleware services and all distributed Grid resources. Furthermore, the LARS can then be substituted by a comprehensive security and access control system such as VOMS or Yagsi, which enable fine-grained role-based security mechanisms in combination with delegation of privileges. However, in this case, a mapping between the organisational ontology concepts implemented by LARS and the VOMS or Yagsi data structures needs to be done by an additional mapping service.

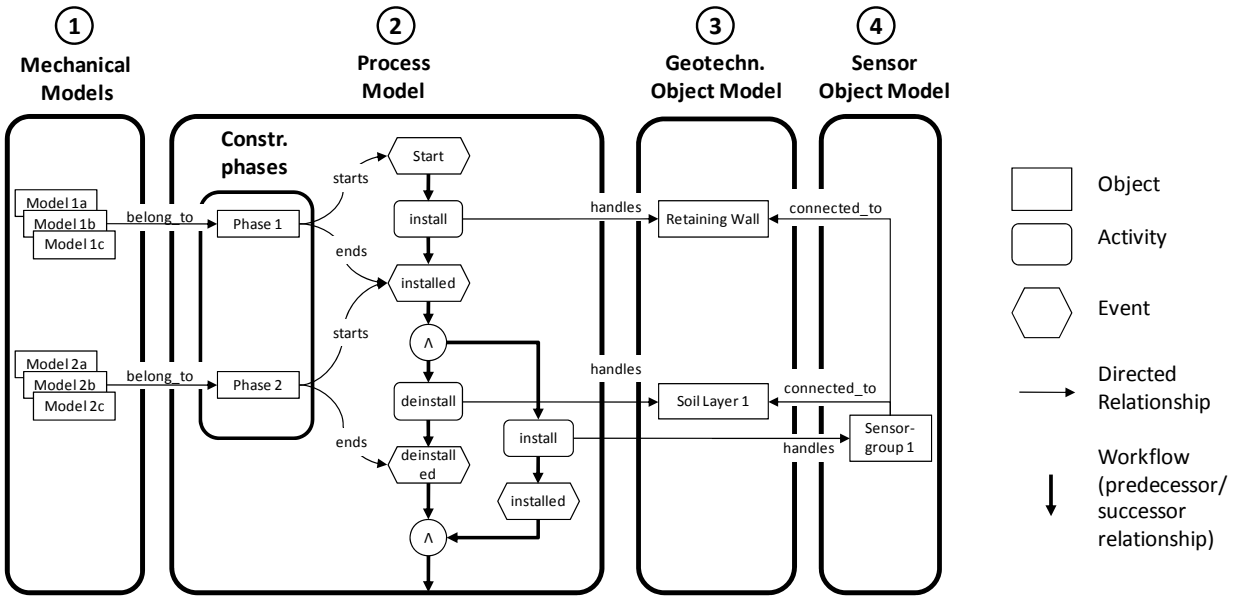
The described architecture provides a convenient way to integrate third-party legacy applications into complex Grid-based production environments for AEC. Currently it is being specifically implemented and evaluated in a defect management platform comprising a project portal, three independent legacy applications of three different companies and a set of semantic-based management and support services.

Integrated Product- and Process Model for Online Prediction and Monitoring of Geotechnical Structures

Gerald Faschingbauer

Objectives

The objective of this work is to considerably improve prediction and monitoring of geotechnical structures during the construction process. Therefore it is necessary to facilitate the continuous measurement of sensor data, comparisons with design data and thresholds and real-time actualization of mechanical models in order to improve predictions of the structural behaviour for adaption of subsequent construction phases. The mechanical problems in geotechnical engineering are usually non-linear, i.e. system identification with unique solutions is not possible. Hence a variety of model candidates has to be used for simulation and a selection of possible best-fitting mechanical models has to be identified in very short time. Therefore the system to be developed has to provide access to distributed resources, e.g. data, models, services and computing power. A crucial aspect is the semiautomatic analysis and management of data from engineering design and observations and the situation-dependent search and integration of reasonable mechanical models and suitable computation services. An ontological product and process model is the knowledge-core needed for (1) reasoning of mechanical models applicable to the observed data and actual context, (2) deduction of measures for the further monitoring and construction process and (3) flexible semiautomatic configuration and adaption of the whole monitoring and prediction system.



Example of a Combined Product (1,3,4) and Process (2) Model for Geotechnical Monitoring and Simulation

Approach

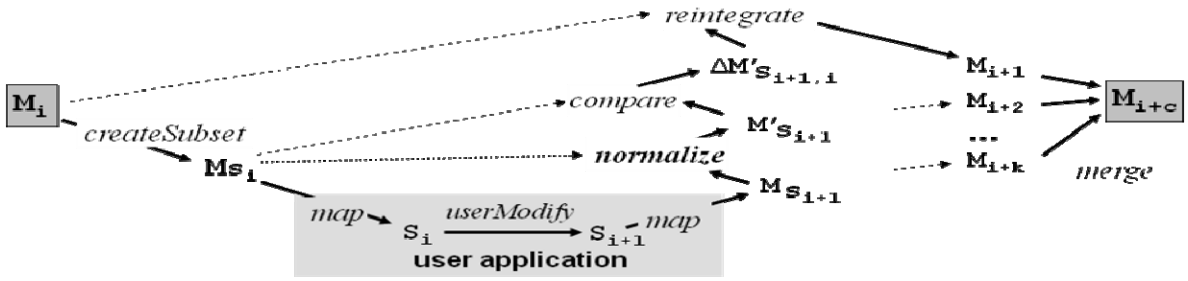
The management of design and monitoring data in the context of the construction process will be realised with an integrating ontological product- and process model that represents both the construction and the monitoring process and which supports their direct linkage to geotechnical and sensor objects. The proposed model will contain (1) the mechanical models representing the behaviour of the geotechnical system, (2) the process models which define the interlinked workflows of both construction and monitoring process, (3) the geotechnical systems and (4) the sensor objects which deliver data about the actual behaviour of the system. An exemplary instance of such model is given in the figure above. The process models will be based on the well-known EPC (Event-Driven-Process-Chain)-Method and combined with 3D product models. A comprehensive product- and process meta model for structural monitoring is already developed in general. This meta model will be further refined and implemented as an OWL-ontology supplemented by rules of inference for situation-dependent selection and instantiation of mechanical models. The consideration and integration of the Industry Foundation Classes (IFC) is intended in order to use their already available basic geometrical and topological modelling resources. As final result a semantic modelling framework is envisaged that supports semiautomatic data analysis, management and context-sensitive system configuration in construction-simultaneous monitoring of geotechnical engineering structures.

Project Information Space Integrated Product Data Management

Ronny Windisch, Peter Katranuschkov

Objectives

The application of product data technology is a key factor for the achievement of efficient model-based collaboration in the construction industry. In practical terms, this means integration of a product model server into a *web-based project environment*, in tight relationship with traditional document management services offered by specialised Web Portals. However, at present portal-based project support is almost fully disconnected from the offered product data management (PDM) functionality. This leads to gaps in the information processing chain, inconsistency of the model data and, last but not least, lower acceptance of the model-based work paradigm in industry practice. Considering the specific characteristics of the design process in AEC, product data management based on the IFC project model has to encompass (1) the creation of model subsets that are suitable for the different discipline-specific work tasks and applications, (2) the ability to detect and manage model changes done to a model subset within a specific work task, (3) the reintegration of the model changes to create a new complete model data set, and (4) the merging of concurrently changed data by two or more designers to achieve a consistent new model state representing the beginning of the next collaboration cycle. However, IFC is a complex model including more than 650 classes and 1300 attributes (IFC 2x3) and allowing different representations for one and the same building information. For example, coordinates and shapes of building elements can be specified in a number of different ways all of which are legitimate. Therefore, as prerequisite for efficient change management an additional *normalisation service* is needed that can provide for harmonised representations of the data before they can be compared and merged.



Required ressources	User activity	Service input	Service output	User activity	PMS activity
Set of model subsets Set of normalization rules	Select model subset Select (& ad-just) normalization rules Service request	Model subset $M_{S,i}$ Modified model subset $M_{S,i+1}$ Set of normalization rules	Normalized model subset $M'_{S,i+1}$ Set of retracted changes Normalization log	(optionally) verifying normalized model subset (e.g. with integrated IFC-Viewer)	Assign normalized model subset $M'_{S,i+1}$ to primal model subset $M_{S,i}$

Specification of the normalization service and its integration into the generalized collaboration scenario

Approach

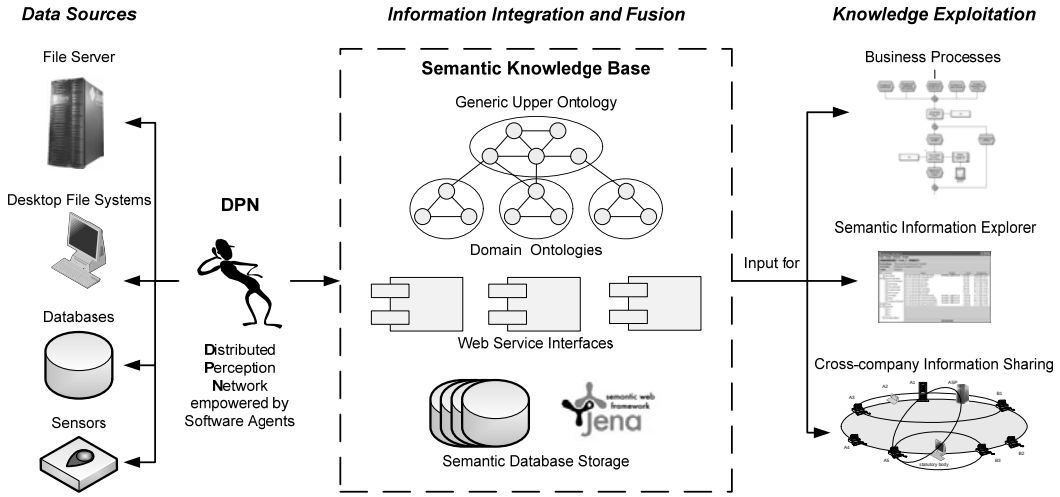
The integration concept is based on the SOA approach. This enables application of flexible, reusable software components being deployed at runtime to provide the required functionalities to existing portal-based project management systems (PMS). The PDM functionality provided by each autonomous web service is well defined; it is described by its expected input and generated output information using the WSDL language. Synchronization and orchestration of the separate web services to complete business processes is based on the required service resources, the involved user activities and the messages to be exchanged between the services and the PMS. For integration of the services on the PMS, dedicated portlets based on a generic template are developed. Message exchange utilises a XML based SOAP protocol for the data representation and HTTP for transport. The developed normalization service provides retraction of altered representations (seen as unintended model changes) to ensure uniform representations of the model data over both the input and output model subsets to be matched. This is done with the help of *normalization rules* that are generically defined for the IFC model schema and adjusted by the user for the specific task context at runtime. The transaction and resource management are combined with the management functionality of an existing PMS environment, thereby enabling consistent and comprehensive role-based support of the collaboration processes and freeing the PDM services from additional management overload.

Gathering and Fusion of Distributed Heterogeneous Information Using Semantic Web Ontologies and Agent Technology

Alexander Gehre

Objectives

A prerequisite for efficient process-centred work is an adequate accessibility of relevant and up-to-date information. Integration of all information will only be successful if it can be treated in a coherent way that allows referencing and accessing it in a single efficient methodology. However, most information in current IT environments is dispersed spatially, accessible by heterogeneous interfaces and coded with task-specific formats. In order to provide for overall information awareness an integrated approach for proficient information gathering and sound information fusion is needed. For the achievement of a maximum of general applicability the approach has to respect a broad set of different information types from simple but dispersed and partially offline sensor data to standard data in files and databases to complex information in multifaceted data models and knowledge bases. In addition, it has to respect that completely centralised data management is not achievable in modern infrastructures with a huge amount of heterogeneous information. To some extent information has to remain on dedicated distributed systems, while a central meta-data management system just maintains significant expressive information about available and even currently unavailable resources. A framework that meets these objectives can provide Business Process Management with a powerful and flexible uniform technique for information integration.



Information Gathering and Fusion using Semantic Web Ontologies and Software Agents

Approach

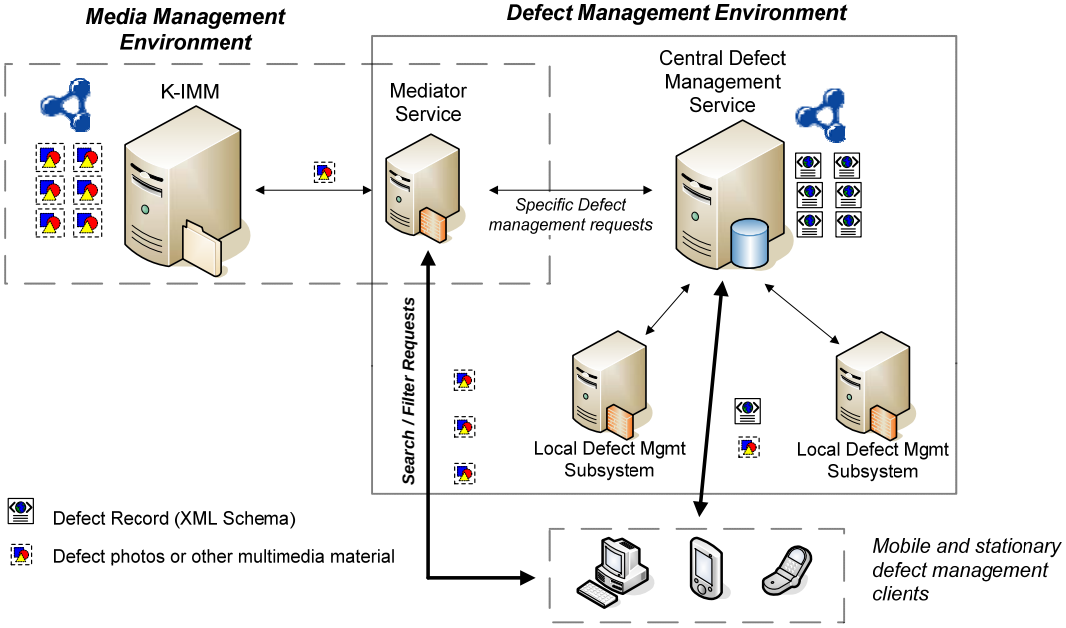
The objectives are met by applying a hierarchical model of general and domain specific semantic web ontologies constituting a semantic knowledge base of the environment. An upper model describes general concepts and specifies modelling principles and constraints. Domain specific models are plugged to the general model, extending it as necessary with specialised concepts and expert knowledge. The complete set of models is dedicated to capture heterogeneous information. If enterprise information resources cannot be integrated directly, only rich metadata will be stored. At runtime the model is used to establish a semantic (virtual) enterprise knowledge base (concepts & runtime assertions). The information and metadata themselves are provided by a Software-Agent empowered Distributed Perception Network (DPN). It is composed of active and passive modules responsible to extract information from all data sources of the enterprise systems participating in the enterprise knowledge base. Usually, participating systems integrate a single DPN module directly; alternatively an autonomous software agent can take responsibility in observation, information extraction, analysis, condensation and integration. DPN nodes can be manifold, from simple sensors observed by agents, to local file systems of employees, to complex databases. For stored metadata, a generic yet flexible methodology for accessing the underlying information resource is an essential part of the system. As all knowledge is captured using one shared ontological system, hidden knowledge can be revealed based on defined rules and automatic reasoners. Information and knowledge contained in the system can be exploited straightforward by business process models that apply the concept definitions in their own model and use the runtime knowledge base during business process execution, e.g. for management of cross-company information sharing and knowledge supported decision making.

Application of an Ontology-based Multimedia Management System for Defect Management in AEC

Peter Katranuschkov, Alexander Wülfing

Objectives

Media management is a vital part of the defect management process in any large construction project. Photos and videos captured with a digital camera or a video recorder can help (1) to document defects unambiguously, (2) eliminate these efficiently, or (3) act as evidence in cases of legal dispute. However, the amount of defects in a project is usually very high, with typical numbers of 10 to 50 thousand, and the amount of associated digital multimedia material is even higher, by orders of magnitude. Even though most media data are generated when such defects are encountered and registered, in various cases this has to be done later, or existing media material needs to be associated with already registered defects. For all such cases, there is a need for efficient semantic-based search and filtering methods along with an appropriate media storage system. This can be achieved by an ontology-based approach. The goal of this research is to analyse how an existing ontology-based system, K-IMM[*)], can be usefully integrated in a distributed system for defect management, and at the same time develop an approach of more general applicability.



Principal architecture showing the major components and their inter-relationships

Approach

In a first step, the capabilities of the K-IMM system are analysed, especially with regard to its underlying ontology model. On the basis of identified general requirements and specific application scenarios this ontology is then adapted to the needs of the defect management system and its underlying defect and process management ontologies by means of an "*ontology mediator*", i.e. concepts specifications that are interlinking the media and defect management ontologies without directly interfering with them. In such a way, system independence and reuse is preserved. Using the developed new "mediator" concepts, a set of search and filtering functions are specified applying time and spatial concepts, such as recording time, mapping GPS coordinates to BIM etc. These functions are implemented as web services with K-IMM used as backend, in accordance with the principal architecture shown on the figure above. Assigning multimedia data to defects can then either be done automatically, when the association can be done unambiguously by the applied search/filter functions, or semi-automatically – with the user selecting the right data from an automatically created list of pre-selected candidates. In the second, more frequent case, human activities can be considerably minimised by using the available semantic (meta) data from the media and defect ontologies in the search query. Such data includes e. g. the status of the defect, the type or category of the associated photos, the work task and the actual location of the user on the site and so on.

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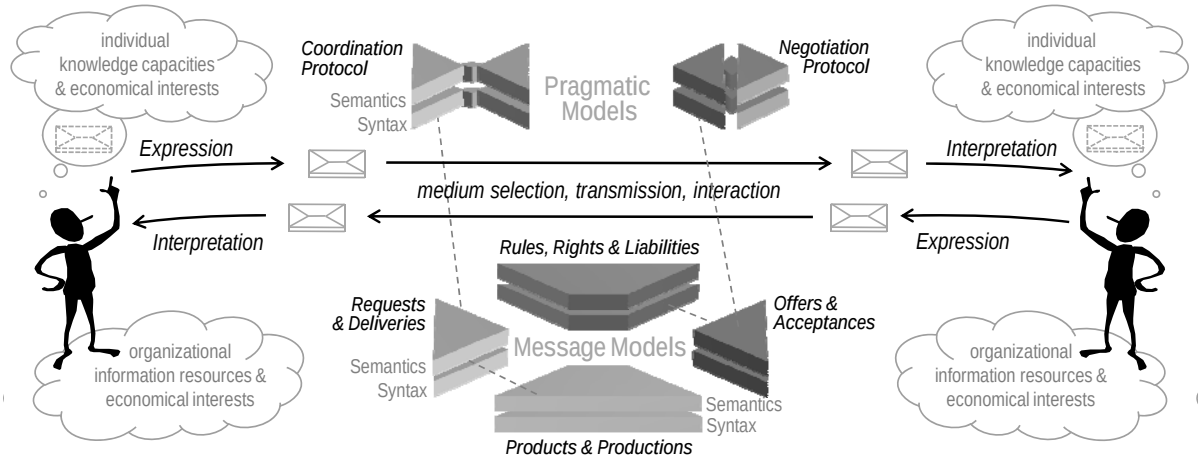
*) K-IMM = **K**nowledge through **I**ntelligent **M**edia **M**anagement is developed at the Institute of Multimedia Technology of the TU Dresden (http://www-mmt.inf.tu-dresden.de/Forschung/Projekte/K-IMM)

A Communication Model for Studying the Applicability of Data Standards in AEC/FM

Sven-Eric Schapke

Objectives

To support the integration of information resources and software applications in AEC/FM numerous data standards have been developed throughout the last decades. Product data models, document schemata, catalogue formats, construction dictionaries and formal ontologies represent neutral reference models for developing file formats, data stores and inter-relating existing information resources. However, the exploitation of data standards in the AEC/FM industry still lacks behind the expectations. To be effectively applied, they need to be implemented in software applications with concerted functionalities that support current collaboration processes. Moreover, to share information among separate business and engineering functions, standards with divergent thematic scope and technical foundation must be combined in coherent application scenarios. The goal of this research is to systematically analyze data standards in regard to the thematic scope, technical formalization and underlying paradigm of their conceptual model. Based on a facetted description, the applicability and potential use of standards in a particular application scenario can be examined and the missing commitments to comprehensively specify its information sharing processes can be identified.



A General Model of Human and Machine Communication

Approach

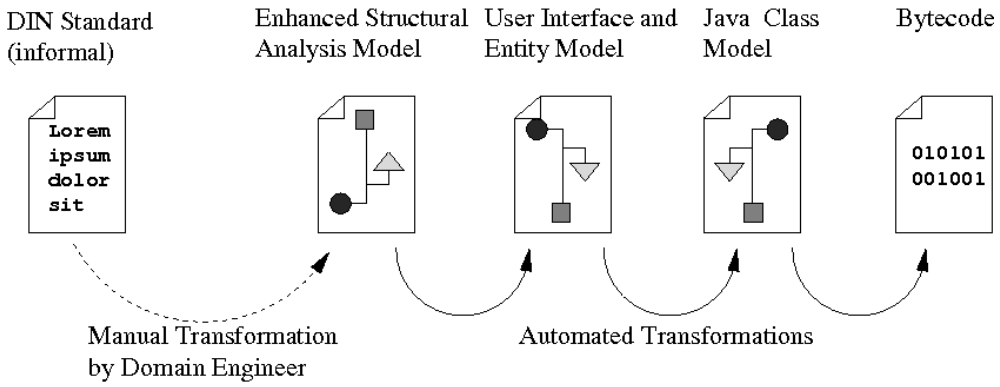
Central point of the comparative study on AEC/FM data standards is a communication model that represents the general aspects influencing the expression, transmission and interpretation of coded information. In our research it is used to define domain-independent categories for the analyses of the structure and formalization of a data standard as well as its potential utilization. The above figure depicts the communication model resulting from a review of models for inter-machine communication and human interaction in dyads, groups and organizations. The model follows the information theoretic perspective, in which information is transmitted in form of messages. It considers semiotic theories, according to which the expression and interpretation of messages is depended on the syntax, semantics and pragmatics of its language. Moreover, studies of inter-person communication are recognized that assume a message as a composition of multiple context-dependent statements addressing different thematic, social and personal aspects. For the examination of IT-supported communication in AEC/FM the communication model is confined to the technical, informational and economical aspects of communication. Overall, the message exchange is defined by four message models and two corresponding pragmatic models that may use different syntax and semantics. The complete message envelope may comprise up to four elements: (1) an economical offer/acceptance message and (2) related contractual information as well as (3) a coordinating request/delivery message and (4) related information resources. Correspondingly, the communication context is defined by the knowledge, information and tasks as well as the economical interests, powers and obligations of the communicants and their organizations. Hence, a full scale application scenario for standard analyses and software design comprises informational and economical models of the work domain and the application context as well as corresponding message and interaction models.

Model Driven Software Development in Construction Analysis

Sebastian Fuchs

Objectives

Due to the nature of its domain, construction analysis software must satisfy solutions to lots of specific, self-contained engineering problems. Because there is no practicable „One size fits all“-approach, software makers have to develop many similar software products. The outcome of this is a need for more effective software development methods to fulfil the vision of a software factory. Following the concept of raising the degree of abstraction, Model Driven Software Development (MDSD) is on its way to become a new programming paradigm. This development method seems to be suitable for software mass production and shall be further investigated. The ideas behind MDSD are: (1) software concepts are explicitly defined in models, (2) a domain specific problem can be expressed much better in a domain specific vocabulary than in a general purpose programming language and (3) strict formalism permits automated software production. Different formal models are used for each abstraction level and are automatically transformed into the next lower model stage until executable code is reached. This fact leads to the idea that any model can bear a meaning for a software behaviour – even if it was not designed by that intention. Goal of this research is to involve construction engineers without programming skills (domain engineers) into construction analysis software development process by defining domain models, i.e. out of DIN standards.



Abstraction Levels and Model Transitions in a MDSD Process

Approach

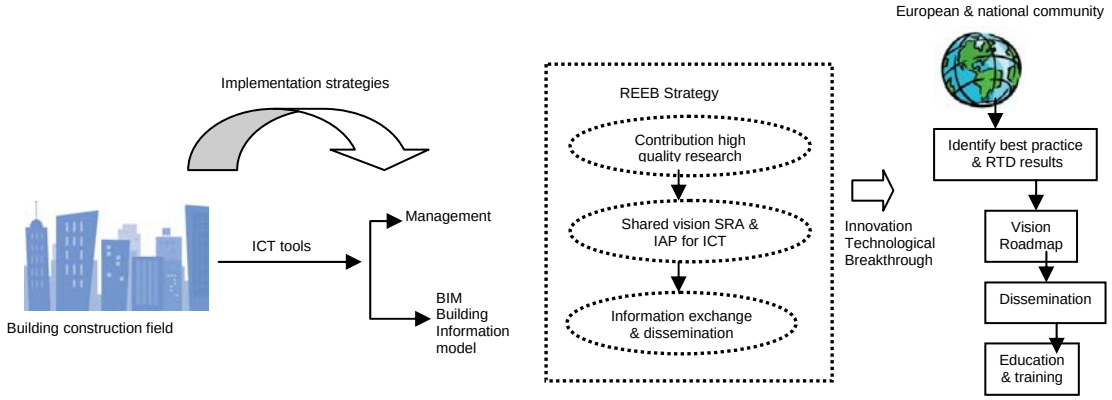
MDSD as a method has to be applied to the construction analysis software domain. Therefore several domain models must be created. A bottom up approach yields models that can be concluded from an existing software platform and its requirements. A top down approach derives models out of construction analysis issues. Both results have to be evaluated and probably mixed up. Due to the method's generic approach of formalization, software tools must be developed which take advantage of formalism and drive the automated development process. In particular these are external and internal domain specific languages, their editors, model transformations, model constraints and automated workflow tools. While tools for building those tools already exist, advanced exploration must be made for IDE extensions and language extensions for existing multipurpose languages. Unobviously, both can be based on models, allow user defined domain specific enhancements to the programming language and are formalized. Special attention is paid to the transition from informal to formal model descriptions – like from DIN standards to a given domain (meta-)model. Given the fact that this is the operational area for domain engineers, user friendly model editors have to be developed in the long run.

Supporting ICT for Energy-Efficiency in Building & Construction

Tatiana Suarez, Raimar J.Scherer

Objectives

Emissions of CO2 from the generation of electricity and heating are the most significant factors affecting and causing the climate change as a result of greenhouse gas emissions. In Europe, between 40% and 50% of the energy generated goes into heating and powering buildings, accounting for around 30% of the carbon emissions. The increasing tendencies forces implementing a range of policies and programs to reduce these emissions while maintaining a secure, efficient and affordable supply of energy. The aim is to identify, synthesise, classify and get to a common agreement of the main problems and challenges related to the future development, delivery and use of sustainable and energy-efficient facilities in buildings, through ICT-based decision-making. ICT in Energy Efficient based solutions covers improved control and management of heating, ventilation, air conditioning, lighting, and other energy-hungry devices, smart metering tools as well as the use of new lighting techniques and the integration of energy micro generation systems**,** providing the basis to organize a new system of energy production and distribution, in which, many small-scale facilities using cleaner and renewable energy sources, complement and replace large-scale power generation plants burning fossil fuels.



ICT for Environmental Management and Energy efficiency

Approach

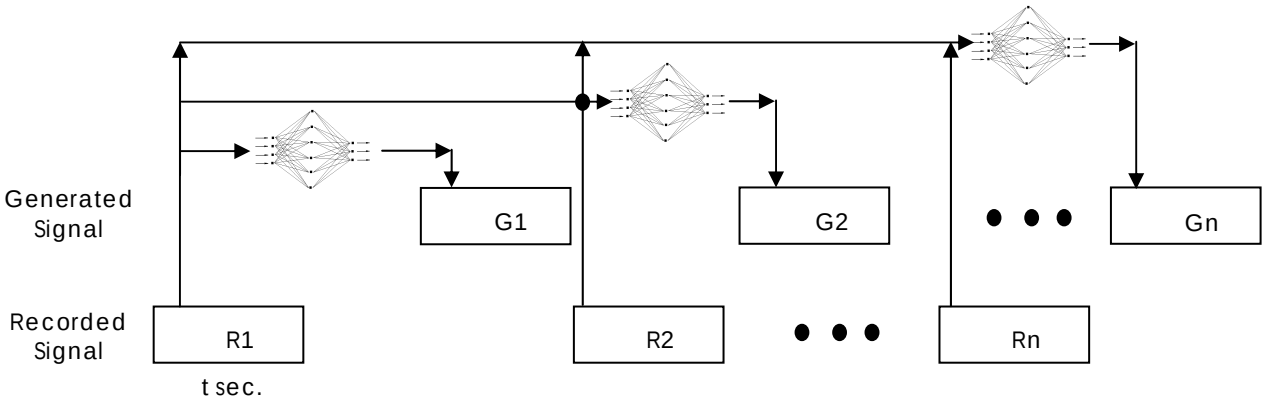
The approach to analyze the possible impact of ICT tools and building information models (BIM) to implement new and improve existing design methods for simulation and optimization, to enhance monitoring and control of both individual parts of buildings and the network as a whole to gain maximum efficiency from the energy generation capacity available. ICT can be refer to micro and nano-electronics components and systems, also to future technologies such as photonics that promise both far greater computing power for a fraction of today's power consumption and high brightness , easy controllable, power efficient lighting applications. The relevant key methods, technologies, models, tools, emerging RTD projects' results with addition of a set of relevant best practices in ICT for Energy Efficiency in Building Construction, moving forward to the work on sustainable development as it relates the activities of the built environment sector, to propose practical solutions to the issues of energy management, resource conservation and minimization of all forms of pollution, with ICT being a key instrument to support such a move. The findings will be synthesized and represented in structured lecture notes prepared for industrial workshops and seminars conducted on a regular basis in different member countries, and for e-learning lectures of the existing European Master Programme co-operatively run by currently 7 European universities, including TUD University and University College Cork.

Real-time Prognosis Model to Generate Earthquake Time-series

Amin Zahédi Khaméneh

Objectives

To run the active control system we need to have an input signal from oncoming earthquake. The conventional active control systems use both delayed earthquake excitation and response of the structure to execute the action force for the actuator. Although the existing active control systems are able to decrease the response of the structure but because of absence real-time data of earthquake they are not capable to make a realistic reaction against earthquake load. Our aim is to develop a Real-time prognosis model to generate the earthquake time-series concentrating on epicentral distance effect, which assess the qualitative relations between the first signals and the whole content of coming earthquake waves. As strong ground motion process is a non-homogenous process with different wave types and different propagation features, the strong ground motion generation must be performed for each wave phase separately (P and S waves). Most conventional models for generating earthquake ground motion process are usually referred to as empirical model or prediction model, since the model predicts the empirical relations usually based on a regression analysis. We use the Artificial Neural Networks (ANNs) to generate the earthquake signal. According to inter-phase relationships, which are between P- and S-Waves, S-wave can be prognosed for most particular application based on the P-wave. According to non-stationarity of the seismic wave even between each wave phase the process is not homogenous and a proper model must be designed to perform in- and intra-phase modelling.



The procedure of modelling seismic wave

Approach

To develop a real-time prognosis model, the local characteristic of earthquake event must be considered. To categorize the soil condition the Eurocode-8 soil classes are used, which has classified soil types according to shear wave velocity of the site, namely in four classes. To take in to account the distance effects, two major categories are defined near-field earthquakes (epicentral distance < 10 km) and far-field events (epicentral distance ≥ 10 km).

The proposed model uses the Artificial Neural Networks (ANNs) to perform real-time prognosis of earthquake event. The following modules will be established separately:

- *Near-field real-time earthquake Prognosis module (NREPM)*
- *Far-field real-time earthquake Prognosis module (FREPM)*

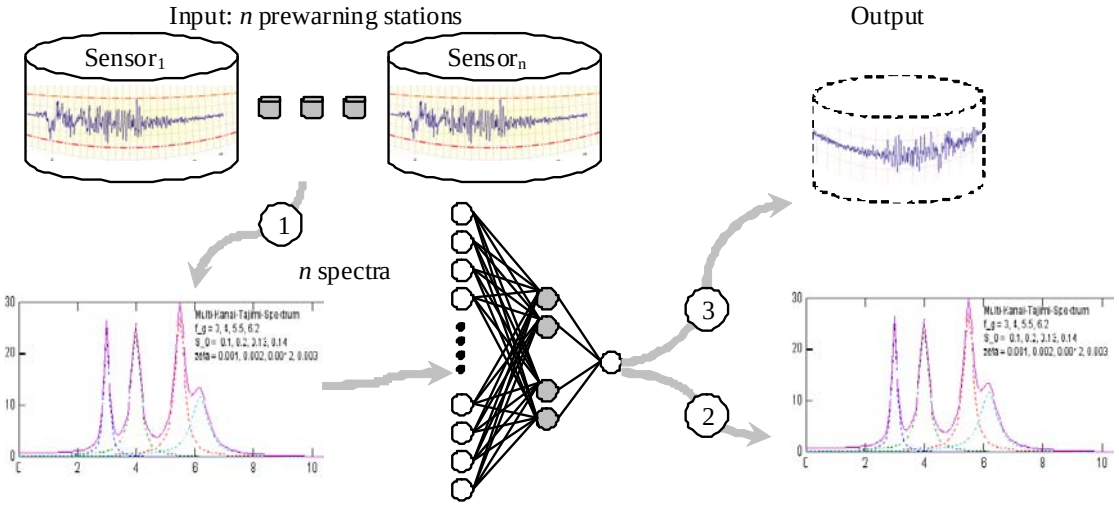
The ANNs are trained for t sec. input signal to generate the next t sec. After each t sec. segment generation, the ANNs use recorded signal from the time zero to the last time step to generate the next signal segment. In order to eliminate the distance effect in FREPM's data bank, the peak ground accelerations (PGA) of far-filed data are scaled, i.e. normalized to the distance of 50 km using attenuation relationships according to each soil type. A feed-forward dynamic ANN with different structures (number of nodes and hidden layers) will be used to detect the more comprehensive form of the network.

Strong Ground Motion Prediction and Generation Based on the Artificial Neural Network (ANN) and Site Parameters

Yaseen Srewil

Objectives

The major challenge in development of earthquake prediction is the achievement of a robust performance at largest possible warning time. The maximal warning time of an earthquake early warning system is generally defined as the time span between *P-wave* detection at the first triggered *Earthquake Early Warning* sensor and the arrival of *S-wave* at user site. Furthermore, the important issues are regenerating the strong ground motion away from source according to the distance, the site parameters and the direction of wave propagation. Especially the seismic response is not uniform, in case the long extended structures, such as long bridges, are considered because at each supporting sub-structure the seismic records might have individual features. Due to the unknown source parameters of the earthquake the ground motion at different sensors in seismic network will be considered and neural networks will be trained to generate the accelerogram at each supporting sub-structure to be used to optimal structural active control.



Schematic diagram of strong ground motion accelerogram generation process of earthquake data between two sensors in the seismic networks according Multi Tajimi-Kanai-Spectrum & ANNs

Approach

The manipulating of the input data from the sensor in the seismic networks will be divided in three steps. The first step is transforming the accelerogram in the frequency domain and using convenient spectral model like Fourier Amplitude of Power Spectrum to capture the essential effects of soil amplification. The spectral function of choice will be the well-known Kanai-Tajimi-Spectrum, a model which describes the spectral response of a one-layered elastic medium. In order to extend it to a more realistic multi-layered medium, the K-T-S approach will be extended to a multi K-T-S model.

The second step of process is using the data from the first transformation as input data to simulate the strong ground motion by using Artificial Neural Networks (ANNs). In our approach the ANN is not trained by the amplitudes of spectrum but with the parameters of multi K-T-S models. This approach will lead to more stable result, because with the K-T-S approach we replaces the real, very irregular spectrum with a smoothed spectral curve, containing only the physical dominant effects and namely the soil resonance effects. Other minor effects are neglected like filtering of signal noise. We will apply the back-propagation algorithm for the training of the feed –forward multilayer networks to predict the parameters of the multi K-T-S at third side, the side of interest. As a result we receive local spectra. For the third step, as an alternative of step two we will train the ANN for the prediction of the time function of acceleration. The difference in both approaches is that the predicted local spectra are much more reliable, because the ANN has only forecast a few K-T-S parameters, than the prediction of the full time function, containing several thousand of amplitude. This is a very important aspect because in earthquake engineering the training set is very limited and hence prediction of local spectra might be the preferable choice.

Lecture Activities 2009

In the new curriculum, that started in the academic year 2006 the students can now choose construction informatics as a competence feature in their studies. This means that in the 3-semester Diploma course, starting with two preparatory lectures two semesters before, students can chose construction informatics as a second subject. As the main subject, Diploma courses are offered for (1) structural engineering, (2) construction management, (3) urban engineering, infrastructure and transportation engineering, (4) hydraulic and environmental engineering and (5) computational engineering. Studies in the Diploma course are organized in modules of 6 hours a week yielding in 5 credit points. The 3 semesters include a project work in the 3rd semester and the Diploma thesis. Both can be done in construction informatics. As construction informatics has to be a complementary subject a pool of 5 modules is offered to the students in order to allow them complementing their basic studies in an optimal and individual way. One of the 5 modules is mandatory, namely WP3-13 "Construction Informatics – Fundamentals", whereas the other two can be chosen out off the remaining four (WP4-XX). Each of the 4 modules is preferably aligned to one of the Diploma courses, which is indicated by intended audience of the course.

Structogram on construction informatics in the civil engineering curriculum

G7 *obligatory*	1st + 2nd semester
GF9 *obligatory*	5th + 6th semester

Diploma/Master courses, if construction informatics competence is chosen

structural engineering	construction management	urban and infrastructure engineering	hydraulic and environmental engineering	computational engineering	
WP3-13 *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	5th +6th semester
WP4-22 *suggested*	**WP4-33** *suggested*	**WP4-60** *suggested*	**WP4-60** *suggested*	**WP4-69** *suggested*	7th+8th semester
select any	*select any*	*select any*	*select any*	**WP4-70**	7th+8th semester

Module G7: Construction Informatics Fundamentals

Intended Audience: Main courses of civil engineering (1st and 2nd semester)
Duration: 2 semesters
Lectures and Tutorials: Scherer/Wagner

Subjects: This module, comprising two courses, provides basic knowledge about algorithms and data structures as well as their modular implementation in an integrated software system. The relational and the object-oriented modelling and programming approaches and the definition and generation of specific views (such as geometrical, topological and graphical representations) are explained on the basis of real AEC objects. The students obtain the ability to think 'object-oriented' in order to structure complex problems modularly and develop generalised modular solutions using algorithms and data structures adequately, with due consideration of their dual and complementary nature. They acquire the capability to formally specify and perform selective, focused modifications as well as further extensions to existing software systems using available software libraries. The module is configured as an e-learning module with object-oriented e-learning tools.

Module GF9: Information Management and Numerical Mathematics

Intended Audience: Main courses of civil engineering (5th and 6th semester)
Duration: 2 semesters
Lectures and Tutorials: Scherer/Reuter

Subjects: The two courses of this module enable the acquisition of knowledge about the basic methods and procedures from the domains of numerical mathematics and information management that are used for the solution of engineering and economic problems in AEC. The students obtain knowledge about principal solution algorithms for linear equation systems and skills in the handling of matrix methods as well as approximation and interpolation techniques, especially using Spline Methods. They learn the fundamentals of Building Product Models and their object-oriented representation which is especially useful for tackling the complexity and heterogeneity of the information resources in construction, the resulting distributed modular data structuring and the related interoperability methods. Basic techniques for the structuring and the formalisation of complex engineering information are presented that empower the students to handle the complex information used in AEC software in such way that it can be efficiently communicated within cooperative design and project management processes.

Module WP3-13: Construction Informatics – Advanced Fundamentals

Intended Audience: All master courses in civil engineering (selectable obligatory module)
Obligatory module for the master courses in Computational Engineering
Duration: 2 semesters (from 5th semester up)
Lectures and Tutorials: Scherer/Katranuschkov

Subjects: The module comprises courses on the topics 'System Theory and Logic' and 'Graph Theory'. It introduces the fundamental principles of Mathematical Logic and provides an overview of the basic rules of 1st and 2nd Order Predicate Logic thereby enabling the acquisition of basic knowledge in conceptual modelling, logical reasoning and consistency checking of complex systems. The fundamentals of Relational Algebra are presented and on that basis the classification of Graphs (as e.g. simple, bipartite, multi- and hyper-graphs) together with their specific properties are explained. Furthermore, the fundamentals of graph based Network Planning are presented including topics like 'paths in networks', 'path algebra', 'flows in networks' etc. Basic knowledge about Petri Nets is also provided to enable the students to (1) develop, (2) formally describe and (3) check in terms of consistency various functions of static and dynamic systems such as the force flows in structural systems, the transportation flow (logistics) in urban planning and construction project management and the overall information and work flows in construction projects (information logistics). The students acquire relevant system-theoretical knowledge and learn composition and representation methods that will enable them to distinguish between various formalisation possibilities such as state-space-based, event-based or activity-based modelling.

Module WP4-22: Cooperative Design Work and Numerical Methods

Intended Audience: Master programme in structural and computational engineering (selectable obligatory module)
Duration: 2 semesters (from 7th semester up)
Lectures and Tutorials: Scherer/Katranuschkov/Reuter

Subject: This module comprises two courses on the topics 'Numerical Engineering Methods and Visualisation' and Methods for Collaborative Work'. The first course imparts basic knowledge about the numerical algorithms for (1) function approximation, differentiation and integration, (2) the solution of non-linear systems of equations, (3) boundary problems in ordinary differential equations of first and higher order, (4) partial differential equations and (5) eigenvalue problems, as well as knowledge about the stability and decidedness of numerical solutions. It provides also principal knowledge about the visualisation of multidimensional variables thereby generating skills to use graphical methods for the visualisation of engineering values and entities in goal-oriented manner, in

order to correctly determine system behaviour. The second course imparts basic knowledge with regard to (1) distributed information management with long engineering transactions, (2) cooperative work methods, (3) workflow methods and (4) data security. On the basis of this module the mathematical and information technology prerequisites for efficient practicing of networked cooperative design work are acquired.

Module WP4-33: Software Systems

Intended Audience:	Master programme in construction management (selectable oblig. module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Katranuschkov

Subjects: The module comprises courses on the topics 'System Development' and 'System Integration'. It imparts capabilities (1) to conceptualise an integrated information system that satisfies the requirements of a construction project, and (2) to use efficiently proprietary software programmes applying as much as possible commonly known, typical tools and standardised data structures. The focus of the acquired knowledge is on practice relevant methods of system development, database design, structuring and application, and the conceptualisation of appropriate interfaces. The knowledge acquired in the area of System Development, includes the preparation and use of requirements analyses, the formalisation of the information process and the information flows, the development of system architectures and of meta data structures, and the definition of programming specifications. The knowledge acquired in the area of System Integration addresses the capabilities to develop the structure of a database using a typical database management system (DBMS), create the database itself using standard software tools, conceptualise appropriate interfaces, and integrate data converter, filter and external web-based services.

Module WP4-69: Simulation and Monitoring of Engineering Systems

Intended Audience:	Master programme in hydraulic and environmental engineering (selectable obligatory module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Reuter/Faschingbauer

Subjects: This module comprises courses on the topics 'System Simulation' and 'Data and Information Analysis'. It enables the acquisition of skills for multidisciplinary conceptualisation, control and monitoring of dynamic processes in engineering systems, as well as for their modelling and simulation and the definition of appropriate interfaces for their modularisation. The students acquire the necessary knowledge about numerical and computational methods for the simulation of dynamic systems and about various approaches for the application of distributed computing. Furthermore, they acquires knowledge of the basic methods for data analysis and data reduction as well as Fourier, principal axis and wavelet analysis. The module imparts fundamental knowledge on Information and Data Mining Methods that will enable the students to correctly interpret the behaviour of an engineering system in order to identify damage and complex damage inter-relationships, system malfunctioning and system gaps, and establish appropriate risk management procedures.

Module WP4-70: Model-Based Working

Intended Audience:	Master programme in construction management (selectable oblig. module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Katranuschkov

Subject: Through the two courses of this module the students acquire capabilities to structure and formalise complex construction projects in order to handle their information logistics and internal relationships efficiently. This enables them to design an appropriate organisational and processing

structure, determine the respective information management methods and procedures and develop appropriate risk management plans. The module imparts knowledge about (1) contemporary modelling methods, (2) object-oriented data structures and the conceptualisation of meta schemas and hierarchical schemas, and (3) interoperability approaches based on methods for model mapping, matching and merging. In the first course detailed knowledge is provided with regard to methods for formal object-oriented system description, the formation of subsystems and consistency checking, and their realisation on the basis of numerical and logical algorithms. In the second course detailed knowledge is provided about the modelling of project processes and process flows, including the complementary information processes and their formal representation.

Module: Building History (read in English)

Intended Audience: Master programme in rehabilitation engineering (1st semester)
Duration: 1 semester
Lectures and Tutorials: Scherer (co-ordination), Curbach, Haller, Herle, Herz, Pohl

Subjects: This module offers a short outline of essential aspects in building history covering the historical development of building technology from medieval times to present. Furthermore the correspondences 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 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).

Module: Information Systems (read in English)

Intended Audience: Master programme in rehabilitation engineering (2nd semester)
Duration: 1 semester
Lectures and Tutorials: Scherer/Faschingbauer

Subjects: This module is comprised of three parallel courses: (1) Management Information Systems, (2) Information Mining, and (3) GIS for Infrastructure Systems.
The first course introduces the methods for object-oriented modelling of complex engineering systems. Further course material focuses on communication methods and the formal representation of communication goals which allow the efficient application of automatic evaluation and decision support methods and algorithms. A third part of the course is specifically dedicated to the use of control methods and the development of a methodology for performance measurement.
The second course introduces methods for data analysis and data mining, such as correlation and regression, classification, decision trees and clustering, whose practical application aims at the early detection of damages and faulty system behaviour. In conjunction with that the scope of application and how the methods are complemented are discussed. Part of the course is specifically dedicated to data pre-processing since the efficiency of the methods strongly depends on the modelled data.
The third course provides 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 lectures and tutorials provide insight into preferred modelling and data analysis techniques for corresponding graphical representation methods.

Course: Informatics in civil engineering

Intended Audience: 6th semester, students of science of the economy
Lectures and Tutorials: Scherer/Reuter

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.

Publications in 2008

[1] SHARMAK W., SCHAPKE S.-E., SCHERER R. J.: Risk Treatment Templates for Configurable Reference Modelling in the Construction Industry. In: IFIP International Federation for Information Processing, Volume 283: Pervasive Collaborative networks, pp.243-252. Luis M. Camarinha-Matos, Willy Picard (eds.), Springer Publishing, 2008.

[2] KATRANUSCHKOV P., GEHRE A., SHAUKAT F. & SCHERER R. J.: Achieving Interoperability in Grid-Enabled Virtual Organisations, in: Thoben K.-D., Pawar K. S. & Gonçalves R. (Eds.) ICE 2008 – Proc. 14th Int. Conf. on Concurrent Enterprising. ISBN 978-0-85358-244-1, pp. 835-842. Centre for Concurrent Enterprise, Lisbon, Portugal, June 2008.

[3] SCHERER R. J., SHARMAK W.: Generic Process Template Description for the Effect of Risks on Project Schedule. CIB-W78, 25th International Conference on IT. ISBN 978-956-319-361-9, pp. 134-142. Santiago de Chile, 15-17 July 2008.

[4] ZAHEDI KHAMENEH A., SCHERER R. J.: Generating the Strong Ground Motion Based on the First Oncoming Signals Using Artificial Neural Networks, 5th European Congress on Computational Methods in Applied Sciences and Engineering, Venice, Italy, June 30- July 4, 2008.

[5] SCHERER R. J., KATRANUSCHKOV P. & RYBENKO K.: Description Logic Based Collaborative Process Management, in: Rafiq Y., de Wilde P. & Borthwick M. (Eds.) ICE08 – Proc. 15th workshop of the European Group for Intelligent Computing in Engineering (EG-ICE), ISBN 978-1-84102-191-1, pp. 291-302. Plymouth, UK, 2008.

[6] FASCHINGBAUER G., SCHERER R. J.: An information management system for monitoring of geotechnical engineering structures. in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[7] GEHRE A., KATRANUSCHKOV P. SCHERER R. J.: Semantic Support for Construction Process Management in Virtual Organisation Environments; in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[8] ICHTEV A., SCHERER R. J., RADEVA S.: Multiple model structural control and simulation of seismic response of structures. in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[9] KATRANUSCHKOV P., SCHERER R. J.: BauVOGrid: A Grid-based Platform for the Virtual Organization in Construction; in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork

and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[10] SCHAPKE S.-E., SCHERER R. J.: Semantic Annotation and Sharing of Text Information in AEC/FM: in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[11] WINDISCH R., SCHERER R. J.: Integrating IFC product data services in distributed portal-based design environments. in: Zarli A., Scherer R. (Eds.) ECPPM 2008 – eWork and eBusiness in Architecture, Engineering and Construction – Proc. of the 7th European Conference on Product and Process Modelling (ECPPM). ISBN 978-0-415-48245-5 (Hardbook), 978-0-203-88332-7 (eBook). Taylor & Francis Group, the Netherlands, September 2008.

[12] HOLLMANN A., WÜLFING A., FASCHINGBAUER G. & RICHLY S.: Semantische Beschreibung und Integration von Ingenieurmodellen in serviceorientierten Architekturen. Forum Bauinformatik – Junge Wissenschaftler forschen. ISBN 978-3-86780-090-7, pp. 69-76. September 2008.

[13] FUCHS S.: Modellgetriebene Softwareentwicklung am Beispiel einer Baustatik-Softwareplattform. Forum Bauinformatik – Junge Wissenschaftler forschen. ISBN 978-3-86780-090-7, pp. 199-208. September 2008.

[14] DOLENC M., KLINC R., TURK Ž., KATRANUSCHKOV P., KUROWSKI K.: Semantic Grid Platform in Support of Engineering Virtual Organisations. Informatica 32, pp. 39-49. 2008.

[15] SCHERER R. J., KHAMENEH ZAHEDI A. & BRETSCHNEIDER J.: Non-Stationary Analysis of BAM 2003 Earthquake Record. The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

[16] GEHRE A., SCHERER R. J.: Ontology-based Agent Supported Information Management for Multi-Organisational Small Project Teams, in: Proceedings of the 12th International Conference on Computing in Civil and Building Engineering, Beijing, China, 15-18 October 2008. Ren A., Ma Z. & Lu X. (Eds.); eBook – ISBN 978-7-89474 Tsingua University Press, 2008.

[17] WAGNER U., SCHERER R. J.: Konzeption eines Werkzeugs für schnell zu erstellende Simulationen von Baustellenabläufen, in: Advanced Logistics Application, Markus Rabe (Ed.), ASIM conference, Berlin 1-2 October 2008. ISBN 978-3-8167-7798-4, pp. 161-168. October 2008.

[18] GÖKCE K. U.: IT Supported Construction Project Management Methodology Based on Process and Product Model and Quality Management. PhD thesis. Berichte des Instituts für Bauinformatik, Heft 7. Dresden 2008

Positions in Editorial Boards of Journals

Advanced Engineering Informatics	Elsevier Publishers	The Netherlands
Automation in Construction	Elsevier Publishers	The Netherlands
Information Technology in Construction (electronic journal)	KTH Stockholm	Sweden
Construction Innovation	Arnold Journals Publisher	Great Britain

Membership in Standardization Groups

DIN Dok-Bau	Standardization committee for technical product documentation in civil engineering	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 for Inter-operability, German Council (product modelling in AEC/FM)	Co-ordinator of the academic group in Germany
IAI/ST-4	ST-4 Structural Model	Vice chairman