TECHNISCHE UNIVERSITÄT DRESDEN

INSTITUT FÜR BAUINFORMATIK

PROF. RAIMAR J. SCHERER

JAHRESAUSBLICK

RESEARCH AND LECTURE ACTIVITIES IN 2012

December 2011

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

Applied Informatics and ***Applied Uncertainty Methods***

The view of the brochure is directed to the future – to the new ideas and plans for 2012 based on the results achieved in 2011. Research topics are: (1) building information modelling, (2) multi-models, (3) interoperability, (4) generic filters, (5) intelligent construction management, (6) virtual organizations, (7) project risk management, (8) dynamic process modelling, (9) simulation and (10) e-learning. The methods and technologies mainly applied are: object-oriented modelling, process modelling, ontologies, description logic, service-oriented architectures, grid and cloud computing, fuzzy and stochastic.

2011 was a very successful year for the institute. Besides the existing three national and three European projects, a new Europe project on energy efficiency “ISES”, coordinated by the institute started in December. Furthermore, a new German project “eWorkBau” will start in January 2012. Due to the numerous projects, cross-project teams were formed focusing on mutual research topics. This led to advanced results, which have been presented at conferences and submitted to several journals. Two of the new research topics are multi-model management and generic filtering, which both extends BIM.

The institute strongly promotes ICT in research and industry. Prof. Scherer is chairman of the European Association of Product and Process Modelling, which will hold its 9th ECPPM conference in Reykjavik, Iceland from 25th-27th July 2012. The conference, being the oldest BIM conference, will this time put special attention to sustainability and energy efficiency. The aim is to bring together leading academic and industrial researchers and developers in construction ICT and BIM (*http://www.ecppm.org*).

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

In October 2011, the institute co-organized the 2nd Mefisto conference at the Dresden (see *http://mefisto-bau.de/congress/congress2*) and the 2nd conference “Bauinformatik – Baupraxis” (construction informatics – construction practice) both supported by the “Dresdner Bauinformatik-Gesprächskreis” (Dresden Construction Informatics Roundtable). The 3rd will be held in September 2012.

E-learning activities have been continued and the related construction simulation program was further developed. With the newly acquired project eWorkBau a valuable acceleration of e-learning is expected in the next years focusing on the BIM access, the development of a domain-based BIM query language and web-based best practice BIM use cases. The European on-line master course “IT in Construction”, co-ordinated by the University of Maribor, Slovenia, is now in its 8th academic year and students can enrol at 7 European universities. For lecture notes on applications of ICT for energy efficiency of buildings developed and collected in the REEB project, see *http://reeb.cib.bau.tu-dresden.de/*.

Collaborative research successfully continued in 2011. Prof. Thomas Froese from the Canadian University of British Columbia at Vancouver stayed with the institute for about two weeks and Prof. Breit and Prof. Häupi from the University of Applied Sciences of Northwest Switzerland visited us for a few days. The PhD student, Larissa Araujo from the University of São Paulo, worked with us on Virtual Organisations for about three month. In October Prof. Scherer visited the Universities UFRGS at Porto Alegre, UFPR at Curitiba, USP at São Paulo as well as in December, the USC in Los Angeles to renew research collaborations or to start new ones. Research collaboration was also newly initiated with the Okan University, Istanbul and prolonged with Prof. Dikbas from the Istanbul Technical University.

A few personal changes happened in 2011. In July, Wael Sharmak left us after successfully obtaining his PhD in April. In August, Hervé Pruvost joined the institute and Tatiana Suarez left us in October. Furthermore, two post-doctoral researchers Umut Gökçe and Ufuk Gökçe came to the institute in early summer to further strengthen our competence in ICT for energy efficient buildings. Amin Zahedi successfully submitted his PhD thesis in November. Ksenia Roos is on maternity leave for one year and she will come back in about October 2012. In July 2012, there will be the 25th anniversary of the professorship of Raimar Scherer. Overall the employees at the institute cover a broad range of expert domains as well as languages with researchers from Bulgaria, France, Iran, Russia, Syria and Turkey.

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

Dresden, in December 2011 Raimar J. Scherer

Institute of Construction Informatics

		Phone extension	Email name
Head of Institute	Prof. Dr.-Ing. Raimar. J. Scherer	3 35 27	Raimar.Scherer
Leading engineer	Dr.-Ing. Peter Katranuschkov	3 22 51	Peter.Katranuschkov
Head IT Lab	Dr.-Ing. Uwe Reuter	3 57 28	Uwe.Reuter
Secretary	Ilona Jantzen	3 29 66	Ilona.Jantzen

Teaching staff

Dr.-Ing. Gerald Faschingbauer	3 42 62	Gerald.Faschingbauer
Dipl.-Ing. Ronny Windisch	3 97 75	Ronny.Windisch
Dipl.-Medieninf. Alexander Wülfing	3 46 15	Alexander.Wuelfing

Researchers

Dipl.-Medieninf. Ken Baumgärtel	4 25 42	Ken.Baumgaertel
MSc Alexander Benevolenskiy	3 57 42	Alexander.Benevolenskiy
Dipl.-Ing. Kathrin Binye	4 25 40	Kathrin.Binye
Dipl.-Ing. Sebastian Fuchs	3 38 23	Sebastian.Fuchs
Assist.-Prof. Dr. Ufuk Gökçe (Visiting Professor)	3 29 66	Ufuk.Goekce@cib.bau.tu-dresden.de
Assist.-Prof. Dr.-Ing. Umut Gökçe (Visiting Professor)	3 29 66	Umut.Goekce@cib.bau.tu-dresden.de
Dipl.-Ing. Arch. Romy Guruz	4 25 44	Romy.Guruz
Dipl.-Medieninf. Frank Hilbert	3 57 43	Frank.Hilbert
Dipl.-Medieninf. Andreas Hollmann	4 25 39	Andreas.Hollmann
MSc Ali Ismail	3 45 30	Ali.Ismail
Dipl.-Ing. Dipl.-Inf. Mathias Kadolsky	4 25 43	Mathias.Kadolsky
MSc Faikcan Koğ	3 57 45	Faikcan.Kog
MSc Zeeshan Mehmood (IT lab)	3 98 17	Zeeshan.Mehmood
MSc Hervé Pruvost	3 57 42	Herve.Pruvost
MSc Ksenia Roos	3 57 42	Ksenia.Roos
MSc Sven-Eric Schapke	3 36 71	Sven.Schapke
Dipl.-Ing. Ulrike Schirwitz	3 46 41	Ulrike.Schirwitz
MSc Yaseen Srewil	3 97 76	Yaseen.Srewil
Dipl.-Ing. Arch. Helga Tauscher	4 25 41	Helga.Tauscher
Dipl.-Ing. Ulf Wagner	3 57 41	Ulf.Wagner
MSc Amin Zahédi Khaméneh	3 49 57	Amin.Zahedi

PhD students extern

Dipl.-Ing. Alexander Gehre	Alexander.Gehre@semproc.de
MSc Nazereh Nejatbakhsh	Nazereh.Nejat@opb.de
MSc Hermin Kantardshieffa	kantards@informatik.htw-dresden.de

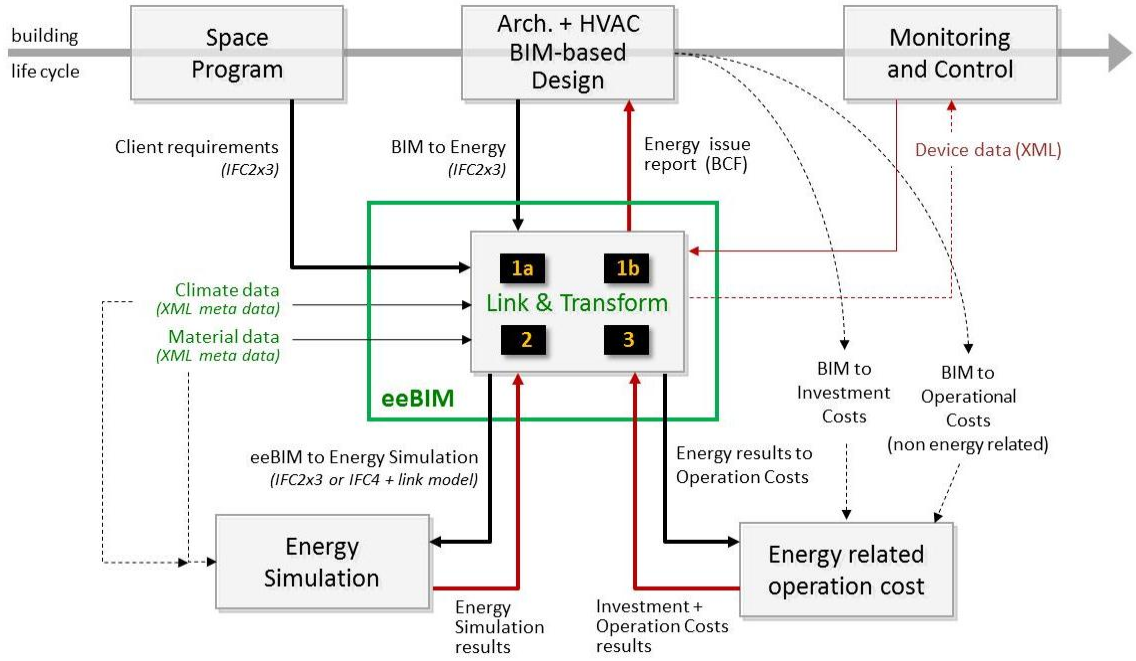
Phone:	+49 (351) 4 63-{Phone extension}
Fax:	+49 (351) 4 63-3 39 75
Email:	{FirstName.FamilyName}@tu-dresden.de
WWW:	http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_bauingenieurwesen/cib
Regular Mail:	Technische Universität Dresden, Institut für Bauinformatik, 01062 Dresden
Packages:	Technische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

Information Framework for a Virtual Energy Laboratory in AEC

Peter Katranuschkov

Objectives

The recent advance of Building Information Modelling in construction practice expedites new possibilities for broader and more comprehensive IT supported analyses and simulations of building behaviour throughout the full building life cycle. However, in order to adequately automate the analysis/simulation processes and make them available for various design, construction and operation tasks, a consistent information framework capable to integrate various needed data sources is necessary. This research, performed in the frames of the EU projects HESMOS and ISES, focuses on the development of such a framework in the particular area of energy and emissions performance and management. The objectives are to (1) develop an energy-extended BIM (eeBIM) providing for integrated lifecycle energy and costs analyses, simulations and decision making, and at the same time (2) propose a generic information system that can be used in the configuration of various other virtual labs (e.g. for wind or earthquake analyses, fire escape or terrorist attack simulations etc.) in much the same manner.



High level view of the suggested eeBIM framework
(data exchange and sharing formats for each type of model transition are shown in parenthesis)

Approach

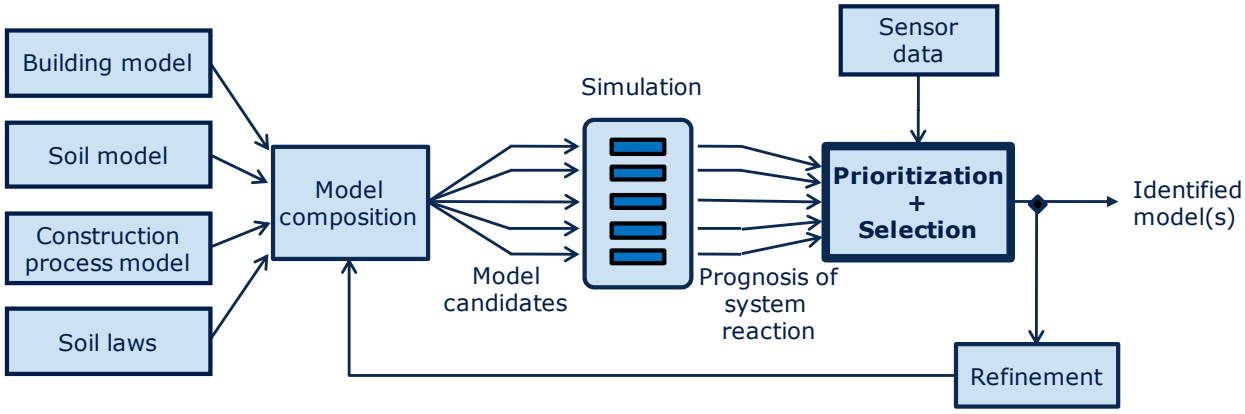
In developing the information framework for a virtual laboratory the first step is to study all information resources that have to be dealt with. These resources can be widely distributed and are typically highly heterogeneous. They may use already established (non BIM) model schemas or proprietary data structures. Hence, neither current standard BIM (IFC 2x3) nor future IFC development can be expected to cover all aspects, all systems and all behavioural characteristics of a building and its environment. BIM provides a basis and a reference schema where all information can be rooted, but there are a number of other information resources to be considered as well in each particular domain. With regard to energy, such resources include climate data, material data and device data from building automation systems (BAS) as well as user profiles. Our approach is not to extend the BIM model itself, but to interlink it with such external resources with the help of a dedicated *Link Model*, based on the concept of the Resource Definition Framework (RDF) of the World Wide Web. This creates a *multi-model framework* integrated via the developed Link Model and a set of supporting model management services for model filtering, automated link creation and retrieval and model transformations (mappings). The latter are important to create elements of the eeBIM framework that have a different data structure than the input data used. Instead of an overarching ontology that would inevitably repeat many BIM concepts we are developing a BIM-related taxonomy and an engineering language that shall provide for the necessary bridge to all external data although, as partial effort, an ontology is also developed for the specific task of integrating BAS data with the BIM.

Prioritization and Selection of Model Candidates in Simulation-based System Identification

Gerald Faschingbauer

Objectives

This work is dedicated to the construction-simultaneous identification of realistic mechanical models that represent physical effects recorded by measurement instruments. Continuous system identification is the pre-requisite for construction-simultaneous, reliable diagnosis of the actual condition of soil, geotechnical structure and surrounding area. Because of the non-linearity of complex soil models closed analytical system identification is not possible. Therefore a simulation-based system identification method according to the following figure is proposed. Model candidates will be composed and sampled by deterministic variation of soil law and soil parameters and the system reaction will be simulated with each of those model candidates. Beyond computational efforts, the high number of model candidates required for this approach and the arising amount of simulation results is hardly manageable by the responsible engineer. In order to reduce the complexity and to provide a manageable basis for the engineering decisions, the automatic prioritization and selection of model candidates is mandatory. Therefore a sofisticated model metric and prioritization methods will be developed, that facilitate automatic prioritization of model candidates based on quantifiable criteria.



Simulation-based system identification with integrated prioritization and selection

Approach

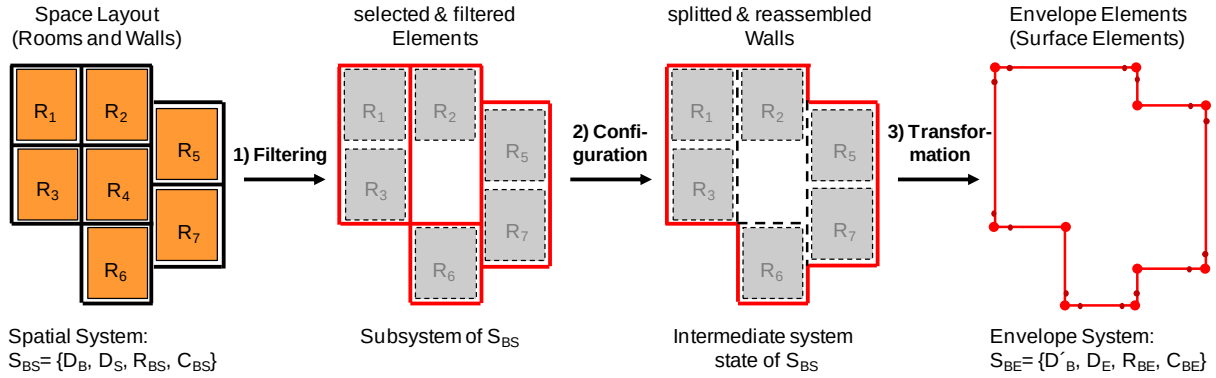
The investigation of examples has shown that only through the interpretation of all measured physical quantities, i.e. displacements, inclination, strains, forces in their entirety an essential contribution to system identification can be expected. As the various quantities and their measurement methods show different impact and reliability on system identification, their contribution to the distance measure should be appropriately weighted. Therefore the influence of normalization and weighting of physical values of interest will be investigated and a problem-specific model metric for prioritization will be developed. The envisaged methodology will in particular consider the following four aspects: (1) estimation of the confidence of measurements based on the confidence level following standard stochastic methods, (2) quantification of the confidence of simulated values utilizing the model and parameter uncertainties of the mechanical models according to the model code developed by the Joint Committee on Structural Safety (JCSS), (3) estimation of the significance of measured physical values for system identification according to the differential dependencies of the investigated soil-structure-system, (4) consideration and weighting of the cumulated measurements recorded over the whole construction process. Finally a methodology for prioritization will be developed that considers reliability of measured and simulated values as well as the significance of specific physical values and the influence of the different construction phases. The prioritization and selection methodology will be implemented as web services and integrated in the orchestration of the overall observation and simulation process. This research work is part of the GeoTechControl project.

A System-Oriented Approach for the Generation of BIM Analysis Models

Ronny Windisch

Objectives

Efficient BIM-based collaboration between experts of different construction domains requires generation of appropriate domain and analysis models that match their specific needs regarding the information requirements and the involved tasks, applications and data models. This cannot be achieved by using current static and dynamic filtering methods (which merely perform information reduction) since the required information is expressed often only implicitly, whereas it is incomplete or missing in the underlying data model (IFC). In order to compensate these drawbacks, the general model-oriented approach should be enhanced by the application of domain-specific engineering systems. This requires a distinction between the physical elements in the data model, representing the functional parts, and the non-physical elements (e.g. rooms, frames) used for structuring the physical elements to engineering systems (e.g. spatial system, structural system, heating system). The spatial system, providing the foundation for the overall design process, is of particular importance here because it represents the initial point for most other engineering systems that are part of the building. Using the overall expressive capabilities of BIM, generic model manipulation methods and specific methods related to the spatial system of a building, this research aims at developing a dynamic and re-usable transition process that evolves the initial model to the desired target system. The goal is to achieve a shift from declarative and static domain model generation to a dynamic, highly automated generation of engineering systems.



A System **S** is a Structure of $\mathbf{S_{ps} = \{D_p, D_s, R_{ps}, C_{ps}\}}$ where
$\mathbf{D_p}$ – Domain of physical elements; $\mathbf{D_s}$ – Domain of non-physical or structuring elements; $\mathbf{R_{ps}}$ – Set of relations between elements of D_p and D_s establishing the system structure; $\mathbf{C_{ps}}$ – Set of constraints indicating the qualification of a relation $r_{ps,i} \in R_{ps}$

Transition from the spatial system to the envelope system required for numerical aerodynamic analysis

Approach

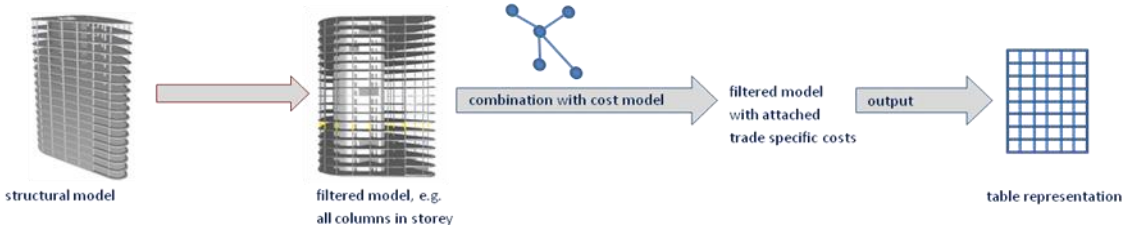
The transition from an initial (source) system to a target system encompasses three fundamental steps: 1) *Filtering*, 2) *Configuration* and 3) *Transformation*, which are the same in principle for every system transition. However, the specific application of these steps may vary from case to case. It depends strongly on the type and structure of the involved systems, their topological, geometrical and functional interrelationships as well as the specific underlying data models. The task of the *filtering step* is to identify and extract the candidate elements that are potentially part of the target system. It involves a selection operation for identification and a difference operation for filtering. These operations use generic and modular filter patterns, which are selected and combined according to the specific interrelationships between the involved source and target systems. The result of the filtering step describes a subsystem of the initial system containing only the elements needed to constitute the target system. This subsystem has to be further evaluated because it may contain elements violating the constraints of the target system (in the case of the building envelope system this can be walls located partly interior and exterior). These elements have to be decomposed, reassembled and rearranged according to the requirements of the target system. This task is carried out in the *configuration step* using division and join operations as well as user input in case of ambiguous configuration options. Finally, in the *transformation step* the elements of the configured sub-system are mapped to the element types of the target system resulting in a change of the elements' representation. The selection and combination of the filter patterns as well as the configuration and transformation steps will be supported by a *system model management ontology* describing the "system knowledge" encapsulated in the systems constraints. This research work is part of the EU project SARA.

An eLearning Supported Filter Toolbox for Individual Information Access from Multi-Model BIM

Alexander Wülfing

Objectives

An ICT based eLearning system for application of Building Information Modeling (BIM) will be developed. As the complete BIM contains a high amount of information that is unnecessary for the work on a specific business task, the filtering of partial models is an important task, in particular for the application by craftsmen. The target of the research is to qualify craftsmen to participate at the upcoming mobile and model-based world of work. In particular the mobile handling of BIM in connection with other business-dependent relevant information is one important learning target. An important part is the integration of different project information, e.g. costs and building elements and their extraction according to user-specific needs. This process is until now mostly done by hand because each business domain has its own proprietary software tools, with a proprietary data format and its own view of a Building Information Model. Therefore for an effective use of BIM, i.e. for a target-oriented access to already available information resources, it is important to supply craftsmen with configurable BIM access tools, i.e. filter and data transformation tools but also with the basic knowledge about BIM data information structures. To extract certain partial models modular filter functions will be developed which can be directly used or combined to complex individual filters. The filter functions will be integrated in a filter toolbox which will be embedded in a web-based learning system.



Extraction of particular elements combined with procurement cost, represented in individual defined lists

Approach

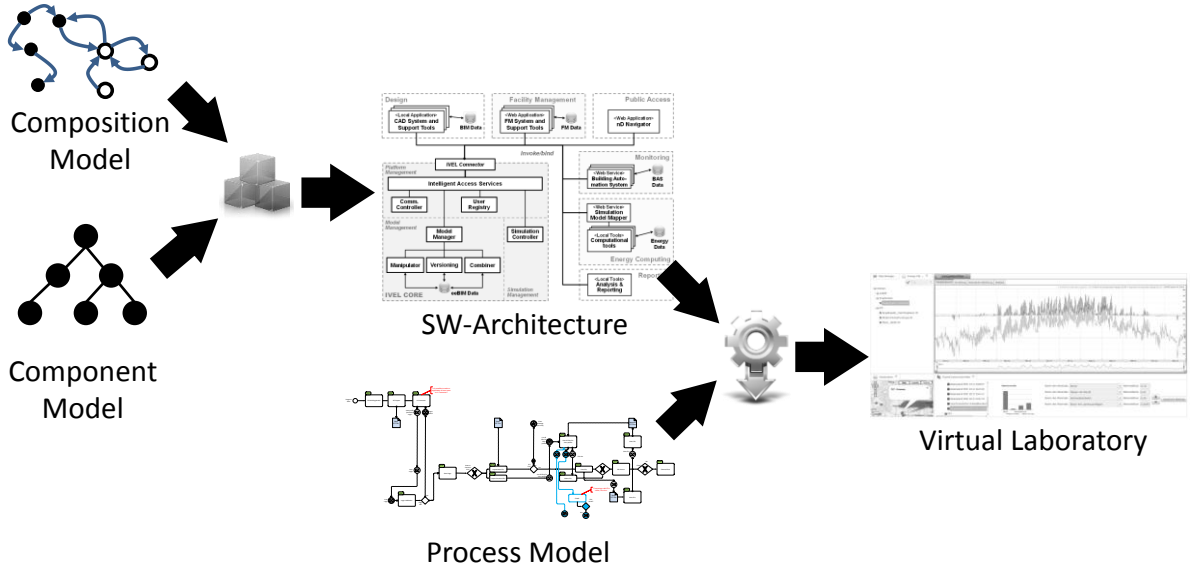
To realize the extraction of model-based information a filter method with a pre-defined set of modular filter functions will be developed. To facilitate both the extraction of specific information for certain instances and the extraction of partial models, the filter functions will allow both filtering on object level and on schema level. The logical core of these filter functions will therefore be based on the fundamentals known from relational algebra and contain the principal select operations of projection and restriction. Projection functionalities will be developed to filter e.g. defined objects of a certain class with defined attributes. Restriction functionalities will allow e.g. filtering of all building elements of type wall assigned to a certain storey with maximum length of 4m. To realize reusability and maintenance of the filter functions they will be further distinguished in three classes: generic filter functions, model-semantic filter functions and application-specific filter functions. *Generic filter functions* will provide filtering on the level of the underlying, meta data structure (classes, relations, attributes). *Model semantic filter functions* realize selection of objects according to their topological inter-dependencies on the semantic level of a domain-specific data model. *Application specific filter functions* work on implicit model information and provide combined selection, transformation and mathematical function capabilities for deduction of information implicitly contained in a model instance. The GMSD method developed at the institute for filtering on schema level will be used as one baseline and further developed and integrated in the toolbox. To make the filter toolbox usable for non-programmers an engineering query language (EQL – Engineer Query Language) is envisaged to be developed in the following up phase to allow formulation of filter requirements in a business task specific manner. The EQL will be consequently one abstraction layer above the toolbox. This research work is part of the mefisto and the eWorkBau project.

Generic Development of a Virtual Laboratory for AEC

Ken Baumgärtel

Objectives

The Building Information Modeling (BIM) shares knowledge resources about a facility to multiple involved users from earliest conception to demolition. To map this definition on a software architecture for covering various use cases, like the facility management, monitoring, wind load simulation or energy performance simulation, the identification of needed components and a generic structure for binding these components with each other is important. This enables complex simulations and evaluations in a seamless way for performing high computing performance Grid and Cloud facilities. Software components must be exchangeable and must satisfy diverse data formats, and hence have to be interoperable. This leads to a generic software composition model, should be able to cover various underlying engineering tasks and use cases with minimal adaptation. Hence, it will be better to define a general approach for generating a ready-to-deploy product of a virtual laboratory by describing a meta composition model of the software architecture and the logic layer.



Generic Process Patterns of the Virtual Laboratory

Approach

A virtual laboratory can be modularized and provides static and flexible services. It is dependent on a given *component model* which forms the contract of any developed module and its components. If use cases changes the composition logic of modules can verify. The composition of the modules will be defined before the deployment of the virtual laboratory and will be described in a *composition model*. While an energy performance simulation needs energy solvers a Computational Fluid Dynamics (CFD) calculation needs CFD solvers to overcome specific requirements. Also the BIM analysis model is changing demanding different compound filter and mapping services. Furthermore, it is possible to enhance such modules to enable a parallelism of solvers and a better scale of the laboratory. To provide a flexible mechanism for the adaptation of a composition model, a meta layer will be adopt which describes a composition formally on a higher level.

Beside flexible services defined in the composition model, there also exist static services of a virtual laboratory which form a *Core* module. This Core connects each other module dynamically and defines centrally the interoperability of different data models in a multi-model management layer. A virtual laboratory for various AEC applications also needs a business process model which describes the interaction of components in more detail and defines the overall business workflow and communication. In a final step, the application can be deployed by using the adapted software architecture and the underlying business process model. This research work is performed in support of the EU projects HESMOS, SARA, ISES, and the GeoTechControl project.

Using Rules for the Configuration of Construction Processes

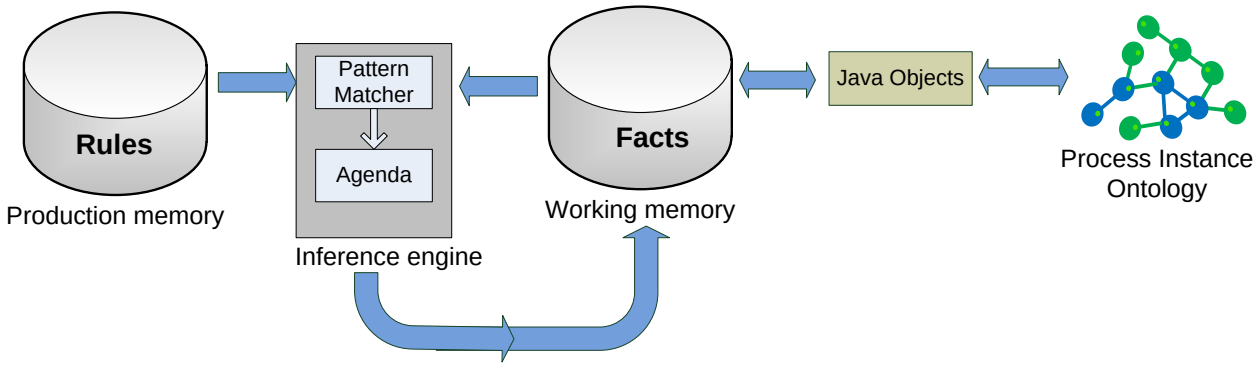
Alexander Benevolenskiy

Objectives

The objective of this work is the development of a methodology for using rule-based configuration methods for complex construction processes. For the formal high-level model of construction processes an ontology-based model is developed.

Due to the use of the ontological structure for the formalization of construction processes there is a possibility to apply a reasoning mechanism in order to inspect, modify and validate the configured processes. Using rules allows us to set and then check various construction constraints and strategies, and perform further process configuration.

A rule-based solution provides a description of complex rules outside of the main application and separates processing logic (rules) from data (facts). Therefore, the rules can be designed independently by construction experts, capsulated in process patterns and easily used in further projects. This allows achieving a better quality of processes. In addition, rapid and easy customization of rules and hence process configuration is possible.



Rule-based process configuration

Approach

According to W3C's Semantic Web and its "Semantic Web Stack" the rule layer stays above the ontology layer. Currently, the integration of ontologies and rules is an active topic of research.

The existing methodologies can be assigned to the two following categories:

- *Hybrid approach:* strict separation of rule and ontology predicates.
- *Homogeneous approach:* both ontologies and rules are represented in the same logical language.

In the current work a hybrid approach is being applied using Drools, an open-source Java-based rule-engine. A proposed rule-based system for the process configuration is currently a part of the Process Configurator and consists of the following three components:

- a knowledge base, in our case – ontologies;
- a set of rules (rule base);
- a control system with a rule interpreter (rule engine).

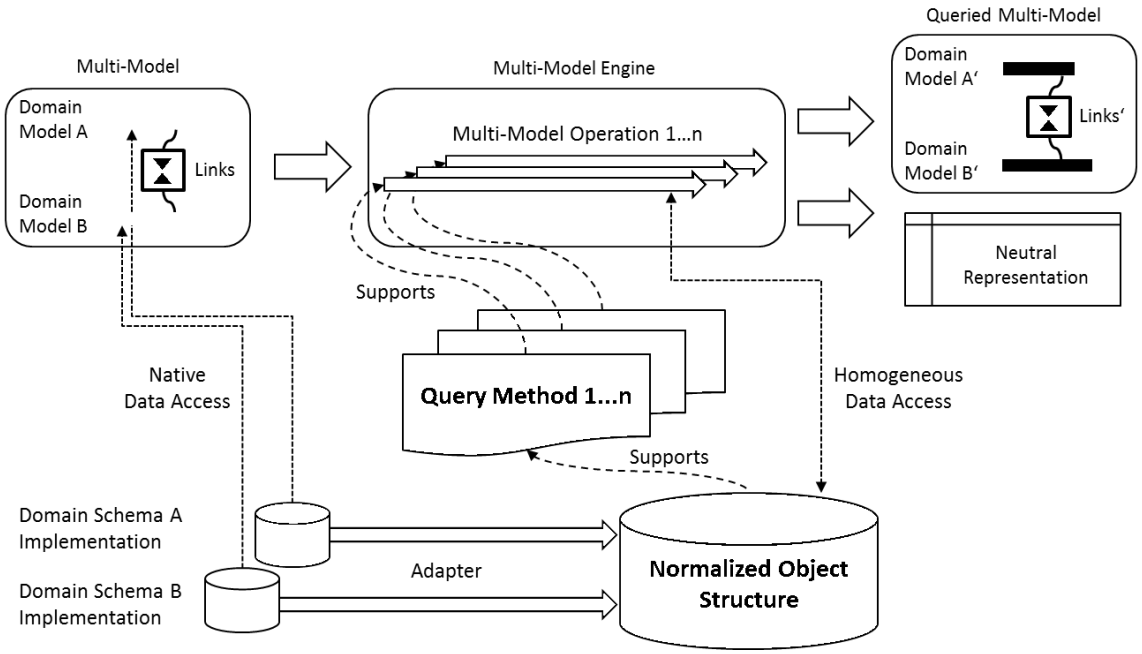
To demonstrate and verify the proposed approach a model of a high-rise building is designed and formalised in IFC. In order to work with this model, some required information is imported from the Building Information Model and used as input data for the Process Configurator. The presented research is part of the mefisto project.

Methods for Querying Managing Multi-Models

Sebastian Fuchs

Objectives

The multi-model approach aims at achieving interoperability in BIM and construction information processes. It allows from the end user point of view interacting with distributed heterogeneous information as with a homogenous data model. It uses the loosely linked original domain models coming from different subject areas, showing different data formats and levels of detail. The multi-model way of working is based on various operations like data generation, linking, filtering, annotation and mapping. Novel multi-model query methods are needed to support all those operations which are subsumed in a *multi-model engine*. In analogy to a database management system (DBMS) these methods are for creation, reading, updating and deletion of data. However in contrast to a DBMS multi-model query methods firstly have to deal with different data formats which are potentially unknown because a multi-model engine must be extensible for additional domain schemas. Secondly they are not allowed to change the original domain models and hence it must be possible to present query results in newly created partial multi-models *and* in a neutral presentation for further external data processing, e.g. visualization or simulation.



Methods for querying multi-models in the context of heterogeneous data formats

Approach

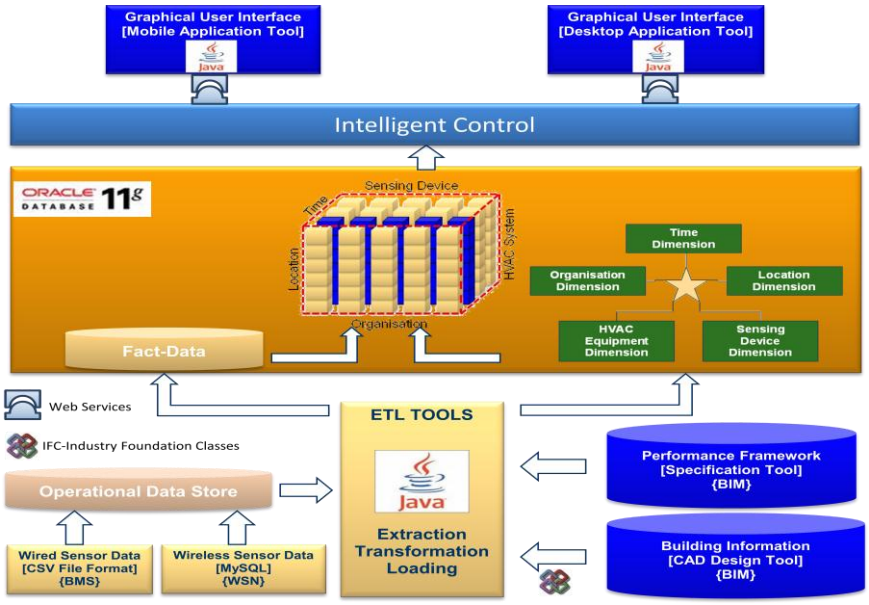
Multi-model query methods are generic methods and must tackle two fields of problems. Firstly on the higher level of abstraction they collectively describe how the multi-model way of working is adopted. That means each method explains how an operation affects the state of a multi-model: the domain models, their contents and the links between them. Therefore qualitative descriptions will be elaborated to clarify possible configurations, elementary procedures and resulting model transitions of each multi-model operation, e.g. a multi-model filter consisting of domain model filters and conditions. Secondly on the lower level of abstraction the methods to develop must explain how to bridge the heterogeneous data formats of the domain models. It is necessary to access data of every domain schema in a homogeneous way to allow interpretable conditions during the execution of a multi-model engine. This should be achieved by a straightforward normalized higher level object structure consisting of *elements* and *properties*. Elements are the parts of a domain schema which can be addressed by an ID; properties are simple data types which are reachable and unique within an element. The actual data access is delegated to the implementer who adapts a specific domain schema. In that way it is possible to grant data access from data format level, e.g. XML or SPF, up to domain specific filters like querying for the (indirect) property *height* of an element *Wall* in IFC. The methods under consideration could form the base for a library implementation and a formal definition of a multi-model query language. This work is part of the mefisto, the SARA, the HESMOS and the ISES projects.

Multi Dimensional Energy Monitoring and Optimisation System for Energy Efficient Building Operations

H. Ufuk Gökçe, K. Umut Gökçe

Objective

Apart from meaningful building insulation measures, the only means of achieving marked improvements in the energy efficiency of buildings is to make use of efficient building automation technologies which comprises automatic control, monitoring and optimization. According to European standard "EN 15232 Energy Performance of Buildings-Impact of Building Automation" building operation systems can, depending on building type and equipment standard, produce the following potential savings of energy: restaurants 31%, hotels 25%, offices 39%, shopping centers 49%, hospitals 18%, schools/universities 34% and residential 27%. Also, it is often faster and less costly to automate building systems than it is to insulate building shells. Thus, flexible and easy to handle monitoring and control technologies are essential. Presently, many sophisticated building services systems are available for facilities management. However, their focus on energy performance rating of buildings is at best sporadic, often comprising an ad-hoc combination of off-the-shelf building management systems (BMS) with some extensions. Such systems provide many problems to building owners with regard to interoperability. The optimization of these systems for energy management adds another layer of complexity to the design and management procedures. It requires analyzing the system, developing new interfaces, replacing devices, newly adjusting and optimizing parameters. In order to address these issues, in this research we focus on (1) establishing a new model-driven development approach that strongly automates the systems from component to application level, (2) the creation of an integrated system concept for optimised building operations, and (3) the development of a multi dimensional data aggregation system for flexible and automated creation of a range of applications and services for energy monitoring and control using modern Data Warehouse technologies.



Multi Dimensional Energy Monitoring and Optimisation System Architecture- Modified from (Gökçe 2010)[1]

Approach

We suggest a new integrated data aggregation and building operations system coupled with open and extensible information exchange facilities to support tool interoperability. It shall offer e-services for energy monitoring and control using data warehouse, data mining and web service technologies. These services structure and aggregate so called "Fact Data" using "Dimensional Data" and are thus capable to respond to complex query profiles required for sophisticated decision support. The information structure is pre-defined in so-called dimensions (e.g. location dimension: building, floor, room) that are used to define cubes. The specific data content, such as HVAC system information and Location information is imported from other data sources, preferably and predominantly via BIM. The proposed system extracts sensor data from the basic BMS and from a wireless sensor network. Collected sensor/meter data is stored in the operational data store (ODS) for data cleansing and redundancy check processes. This pre-processed data is loaded to the fact data section of the data warehouse system via an Extraction, Transformation and Loading (ETL) tool. Concurrently, data gathered from the building information model, e.g. via a BIM-CAD system, is loaded to the dimensional data section of the data warehouse. Loaded fact data and dimensional data is aggregated in the data warehouse core to maintain actionable information for the novel Monitoring Tools and Intelligent Control module which comprises scenario based intelligent control algorithms.

[1] Gökçe, H.U.," Multi-Dimensional Analysis of Building Performance Data for Energy Efficient Building Operation", PhD Thesis, National University of Ireland, Cork, 2010, Ireland.

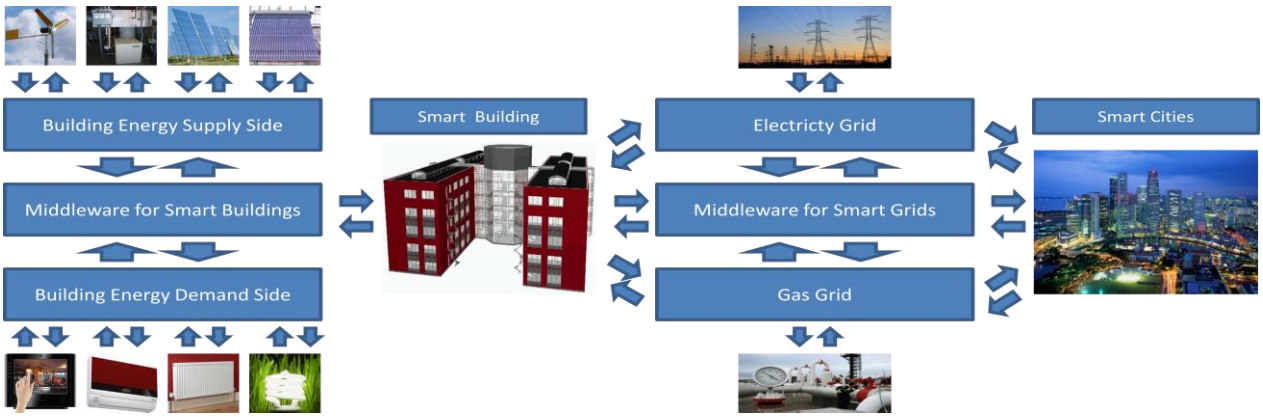
Holistic System Architecture for Energy Efficient Public Spaces

K. Umut Gökçe, H. Ufuk Gökçe

Objectives

Current studies show that improved building control systems can contribute to the reduction of energy-consumption of buildings by 5 to 30 percent. At the moment sophisticated building energy management systems are available for facilities management. However, their focus on energy performance rating of buildings is at best sporadic often consisting of an ad-hoc combination of off-the-shelf building management systems. The optimization of these systems for efficient energy management adds another layer of complexity to the design and management procedures. It requires analyzing the system, developing new interfaces, replacing devices, and optimizing parameters.

Furthermore the engineering and deployment of efficient energy production systems for buildings addressing the renewable energy technologies (wind and solar power) and integration of these systems with the ICT-based sub-systems becomes a necessity. Integrated IT tool support for these activities does not exist; available tools are stand-alone products, often tied to specific standards. This lack of appropriate descriptions and tools currently outweighs the benefit of software interoperability. As this technology gap spans for all application domains, it will likely hamper further adoption of IT solutions. In this regard, the prospective consequence of the building behavior and the needs of the building occupant/operator which would manage energy production/consumption efficiently would not be predictable with a single combined information, communication, hardware and tool platform. A promising approach, to overcome these shortcomings, is the implementation of a holistic, modular infrastructure.



The Integrated Concept of a Holistic System for Energy Efficient Public Spaces

Approach

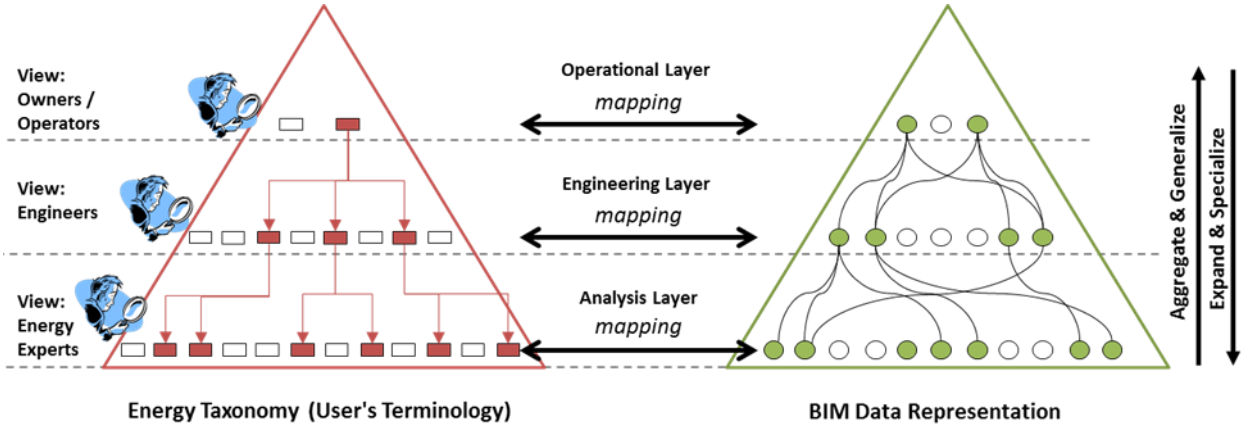
In the first phase of this research which will be extended to smart cities level, the need of integration structures, holistic monitoring and analysis methodologies, life-cycle oriented management and decision support of both facilities and service teams with considering two key research areas (1) Building energy supply-side management which addresses the energy management systems capable of optimal integration and control of energy production addressing renewable energy technologies (wind and solar power, geothermal heat pumps, energy storage systems) and the (2) Building energy demand-side management a scalable, robust wireless sensing network platform that integrates sensing network platform and actuation to collect build-use data through advance data monitoring and data mining technologies which lead to develop optimal control algorithms that adjust HVAC set points to adapt to occupancy, weather loads and their predictions, minimizing total energy consumption and peak demand while maintaining the indoor environment within user preferred comfort parameters. The main goal in this research is to provide a holistic environment and system chain enabling the efficient use of renewable energy technologies and building energy management systems in a holistic building energy supply and demand side energy management concept which will be extended to city levels. The proposed concept is maintained in an integrated approach by developing (1) Optimal Integration and Control of Renewable Energy Resources for Building Energy Supply Side Management, (2) Sensing Network Platform and Data Warehouse Technologies for Building Energy Demand Side Management, (3) Middleware for Smart Buildings. In the second phase of this research the (4) Middleware for Smart grids will be developed to provide the information exchange required to work cooperatively with Electricity and Gas Providers.

A Multi-Layered Taxonomy for Planning and Decision Making Based on a Virtual Energy Laboratory

Romy Guruz

Objectives

Architects, engineers, owners, public authorities, facility managers, operators and expert energy analysts all do have different requirements on tools and systems used in their energy-related construction tasks. This leads to various challenges that have to be met in the aim to develop an *Integrated Virtual Energy Laboratory* (IVEL) that can enable the interoperable use of multiple energy and related calculation systems, building monitoring and control systems by all types of users involved in the lifecycle of a building. The specific objective of this research is the development of a *linguistic concept* related to a formal Building Information Model (BIM) that will allow representing the individual specific knowledge of every type of user and her/his particular demands on different level of details. This will provide for informed inspection of the energy performance of the building and adequate behavior analyses/simulations with regard to the user's level of knowledge and decision-making. The final goal is the realization of a software platform in which all analyses are performed on the appropriate level of abstraction and results are presented in the best suitable form for decision-making via an *intuitively applicable query language*.



Layered energy taxonomy (left) and associated BIM levels and data manipulation methods (right)

Approach

To enable structured representation of all specific user requirements and appropriate view on the data, matching her/his level of knowledge, we structure the user models into three levels of detail:

- *Operational Layer*, suitable for clients, owners, facility managers and building operators,
- *Engineering Layer*, suitable for architects and service engineers, and
- *Analysis Layer*, addressing the needs of highly specialized energy experts and computational engineers.

The terms of the linguistic model have to be uniquely defined and thus almost intuitively usable at each of these layers. Moreover, they should allow functional extensions, to provide for querying the underlying tools and systems, and triggering respective energy analysis and simulation tasks. To achieve that, an energy system *taxonomy* is developed that links the key elements of the appropriate formal data models to the respective linguistic terms. The basis of the taxonomy development provides a generalized formal requirement specification of the energy-related processes performed by the various types of users in the lifecycle of a building. The structuring of the taxonomy and the respectively performed layered decomposition of the BIM data reflects this specification. The *Analysis Layer* (at the bottom) encompasses the detailed material and climate parameters that are used in energy simulation methods and low-level building automation system monitoring. On the *Engineering Layer* these data are aggregated and generalized to physical devices and building elements, which are in the focus of design decisions with regard to energy performance (room use, their enclosing, surrounding walls, floors, doors and windows, the HVAC system, including heaters, ventilators, pipes etc., the lighting system and so on). On the *Operation Layer* (at the top) the data is further aggregated to very general end user concepts and requirements such as temperature ranges, lighting demands, costs for energy etc. To achieve the envisaged functionality, methods are being developed to map the taxonomy concepts to respectively generalised and aggregated (bottom to top) or specialised and expanded (top to bottom) BIM views. The performed work is part of the on-going EU projects HESMOS and ISES.

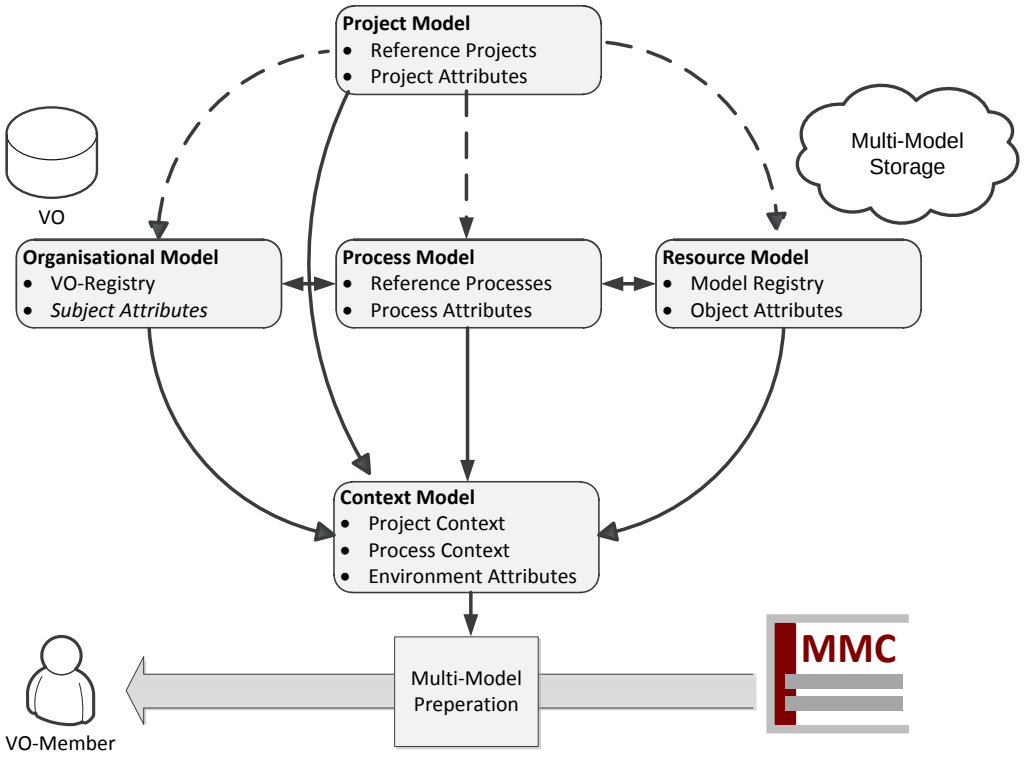
Context Sensitive Access on Multi-Models

Frank Hilbert

Objectives

Throughout a construction project there are numerous architecture, engineering and management models created and utilized. To exchange these application models and explicitly indicate their dependencies the multi-model container format was developed. Within the multi-model application models from different domains and various project participants can be interlinked. However, depending on the different tasks and disciplines, not all the involved partners necessarily need to know all models of a container in every technical detailing. Moreover, the not all participants may have access granted to all contained models as well as the size of the container can lead to delay in communication.

According to the current processing context the partners in a Virtual Organization need only task-specific parts and permissions of a multi-model. Hence, the objective is to realize *context-sensitive access filter* that consider the context of the user, their task and the related resources. This access context is the dynamic conditions while executing an action or accessing an object and is dependent from spread context attributes and include various static (project context: organizational structure, potential roles with permissions) and dynamic context attributes (process context: object status, subject status, subject-object relationship and project status).



Generic Approach to use Context Model for multi-models in a VO Environment

Approach

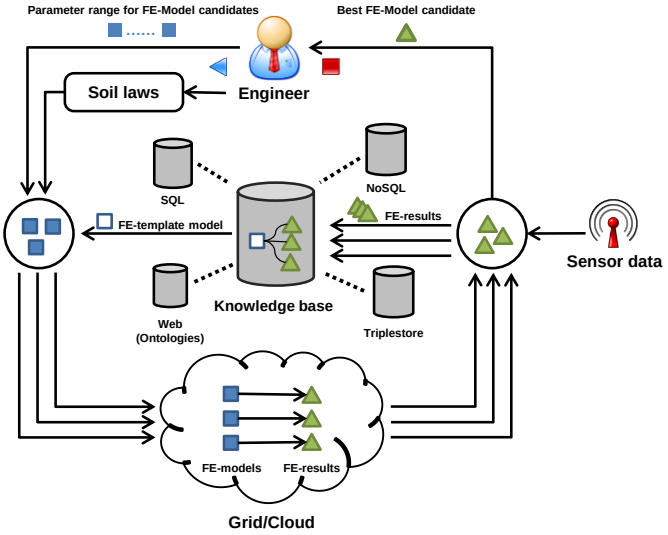
To use this information for a *context-sensitive access filter*, it is necessary to formally describe these context attributes. The objective of this research is therefore to define a *context model* to describe this dynamic context information that can build on metadata as well as content information from the application models. To describe the access context precisely, a context model is used which binds together distributed context information. For this purpose, the context attributes (aspects from) of the project model, the organizational model, the process model and the resource model are linked into one context model. For the context attributes of the objects, in our case, the meta-information from the container description are used, which includes also information on all contained domain models as well as information about the link models. The context model allows describing differentiated requirements of the transferred multi-models using multi-model templates. As a result we get a context model, which we can use to generate cutouts to facilitate spread processing and enforcement of data protection in the use of multi-models in virtual organizations. So we can ensure that the involved VO members get a simplified view of complex multi-models as well as sufficient permissions depending on their tasks.

Using Semantic Web and Grid Technologies for Solving Inverse Problems

Andreas Hollmann

Objectives

Due to the high uncertainties of the underlying geotechnical models complex construction projects in geotechnical engineering typically require continuous, construction-simultaneous monitoring and identification of soil models that best-possible represent the actual system behavior. To cope with that challenge simulation-based system identification method will be developed, which supports semi-automatic generation, processing and analysis of a high number of soil model candidates. The results of these simulations will be compared and prioritized to the real-world situation. In that way the most realistic soil law and its parameters can be identified and used later for system diagnosis and improved prognosis of following up construction phases.



System identification workflow cycle

Approach

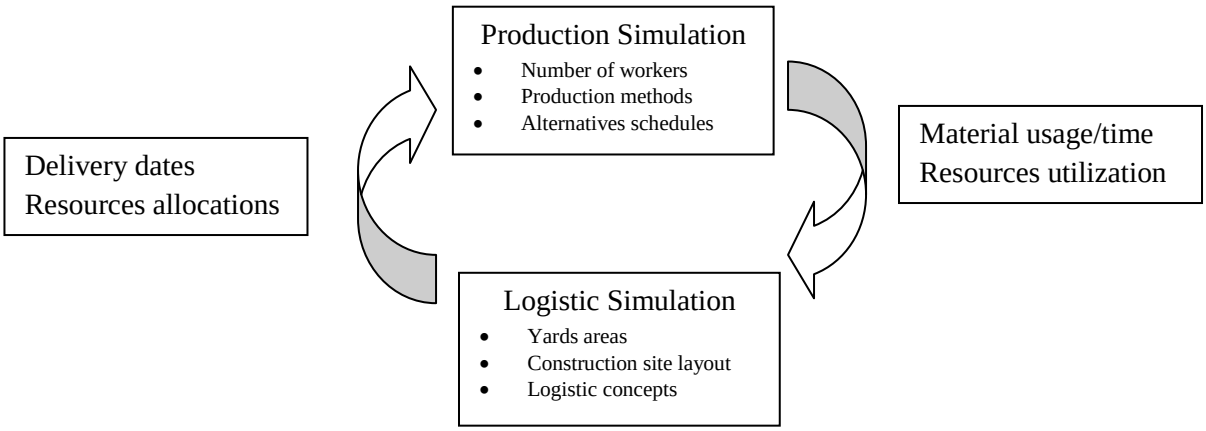
To realize continuous system identification a web based software concepts for a continually executed measurement and observation cycle with integration of FEM-Service is under development. The parallel finite-element simulation and the management of the various soil model candidates with varying soil parameters and soil laws will be realized via a distributed architecture including web-services, different kinds of data and knowledge stores as well as a web-interface for user-system interaction. The current version of the developed FEM-Service provides semi-automatic instantiation of a high number of FE-model candidates and their computation on a webserver. Later FEM-Service will be extended for Grid and Cloud computing. All FE-results and meta-data can be extracted from the output file, stored in a relational data structure and further processed. The architecture of the FEM Service is foreseen to offer exchangeability of the computation core (solver). At present the SOFISTIK finite element core is used. The objective of the next research period is the development of sophisticated knowledge-based methods for the generation and prioritization of FE-model candidates, in particular with consideration of plausibility for selection of soil laws and parameters. The engineering knowledge about possible physical effects and soil laws as well as meaningful soil parameter ranges, dependent on the type of soil will be represented in a knowledge base. The concepts of the knowledge base will be implemented in OWL-DL. Rules for the selection of soil laws and parameters appropriate for the given situation will be developed and implemented using the semantic web rule language SWRL. To enable the automated instantiation of plausible FE-model candidates this knowledge base will be connected to the existing FEM-Service. Web services for the description, classification, publishing, search and integration of soil-laws will support the availability and utilization of the high variety of existing sub-routines of soil laws. The determination of soil laws and parameter ranges will be sophisticated using the experiences from results of already computed models via implementation of a case based reasoning concept. This research work is part of the GeoTechControl project.

Interactive Simulation for Production and Logistic Operations

Ali Ismail

Objectives

Production and logistic simulation studies are done usually separately. The interactive relations between production and logistic operations (e.g. material transport) are ignored in many cases for simplicity purposes. In this research we are trying to analysis the influence of both simulations on each other using continuous and repeated algorithms to be used as a decision support tool. The goal of this research is to investigate various "What if" scenarios to help inspecting the effects of different production/logistic concepts. This kind of advanced analysis is important to improve the effective use of shared resources among many construction projects and to analyze the robustness of project schedules due uncertainty and disruptions like bad weather or lack of materials.



Interactions between production simulation and logistic simulation

Approach

A set of simulation components have been developed for a rapid deployment of simulation models in construction industry domain. They integrate the required input data from different domains. Process templates are used as central elements to describe formally the construction processes based on Business Process Modelling and Notation (BPMN) specification. The primary results of production simulation like material usage and resources utilization are used as input for the logistic simulation with the assumption that all resources are relaxed and the storage areas in the construction site are not limited. According to the resources availability, real capacity of storage areas, and the logistic concepts the delivery dates of material may change. The new results of logistic simulation will be used as input data for the next production simulation run. Repeating this process many times with help of Monte Carlo simulation method taking in account the uncertainty of construction processes (stochastic values of productivity coefficients, statistical distribution for material transport time, weather effects, etc) gives an overview of probable duration to finish the project milestones and possible bottlenecks.

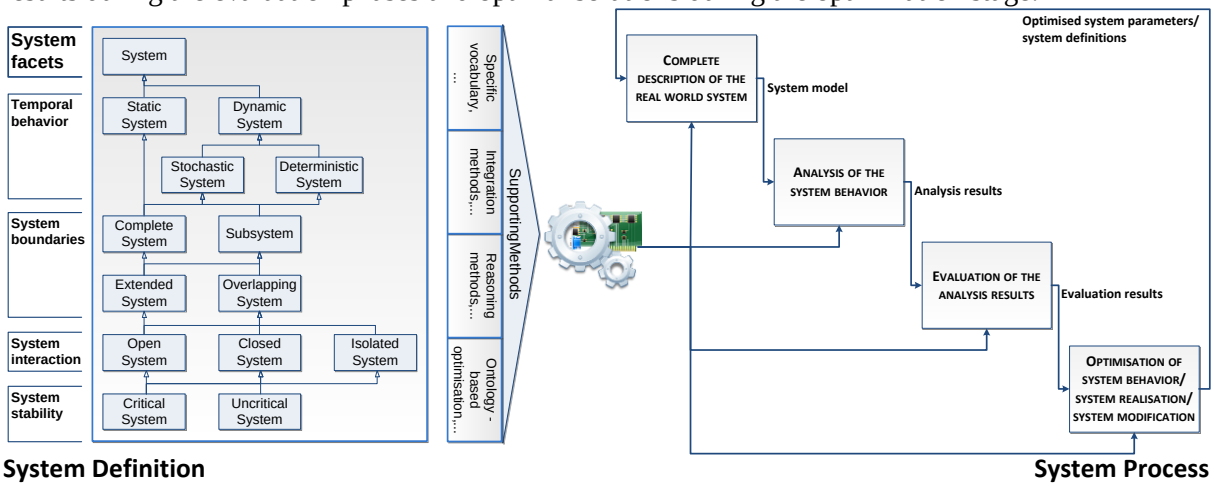
The simulation components and the process catalog will be extended to integrate material flow and logistic operations with production operations. This research work is part of the mefisto project.

An Ontology-based Approach for Defining and Managing Model Systems in BIM Specific Domains

Mathias Kadolsky

Objectives

Today's BIM-based description methods like the IFC are geared towards widespread application. While they offer general vocabulary covers different fields of civil engineering and allows the definition of additional concepts for specific application domains they lack defining certain engineering systems like the envelope or the load bearing system of a building. This is due in particular to the fact that an underlying semantic framework is missing comprising a uniform denotation of system elements and a functional description, which restricts their application by following a task specific orientation. Therefore, a dedicated description providing the necessary vocabulary for the definition of systems is needed preferably realized as ontology to allow generic rule based presentations. This aims to the expansion of existing description methods with an appropriate terminology in order to identify, configure and transform different engineering systems for further processing. It supports the analysis of a selected system behavior by defining the relevant interconnections of the involved systems realizing for example the load transfer between the envelope system and the load bearing system of a building or engineering structure. Furthermore, the ontology-based description enables the possibility to formulate a set of logical rules helps to identify unfeasible results during the evaluation phases and optimal solutions during the optimization stage.



Ontology-based system definition supporting the different phases of the system process

Approach

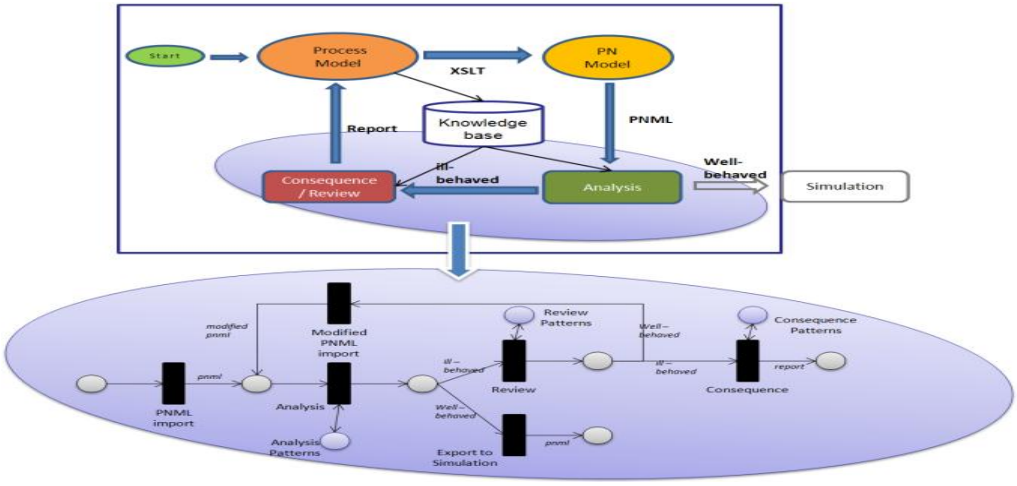
The starting point for the development of the ontology forms the classification of relevant system types. This classification is organized as facet classification establishes the basis for defining polyhierarchical taxonomies derived from the combination of different facets. Here, four facets are introduced: temporal behavior, system boundaries, system interaction and system stability. With the characteristic of the temporal behavior static systems, which preserve their original form over time, are distinguished from dynamic systems, which signify more than one possible state. Thereby, the states result from deterministic or stochastic processes. System boundaries are specified as further facet by the set of elements, relations and rules. They indicate whether the system definition describes a complete system, a subsystem, an extended system or an overlapping system. While a subsystem in contrast to a complete system does not provide the whole information for supporting the system process the latter two system types additionally encode that a part of the defined vocabulary is fully or partly contained in another system or subsystem. The interaction between systems serves for the exchange of information carried out in two directions. At this, open systems send and receive information, closed systems only receive information and isolated systems do not communicate with their environment. Finally, systems can react in different ways to changes. So, if small modifications of the system parameters cause inconsistencies in the system the system is defined as critical system otherwise it is called uncritical system. The further elaboration of the taxonomy and the development of the whole ontology is part of the research work in the mefisto project.

Process Modification Patterns for the Verification of Business Process Models Using Petri Nets

Faikcan Koğ

Objectives

Business Process Modeling (BPM) is a technique for modeling and analyzing business processes in order to improve process efficiency and quality. Multiple BPM tools, which are for manual modeling, have underlying capabilities such as simulation that helps business managers and analysts to understand the complex processes and to quantify the system's performance. Nevertheless, developing valid simulation models is a still complicated activity, because of the incorrectly or inflexibly modeled business processes. The same situation holds also for the construction processes, which consist of very complex and detailed processes and are not easy to model or to integrate with each other. Process configuration, which is a method to integrate several business process variants into a single model, helps to omit unnecessary process parts and to give flexibility to the modeled business process. Even though there is a configured process model for a construction process, verification of the completeness and consistency system network and validation of the intended purposes of the model is still a problem because of the complexity. Process modeling tools must support the process configuration with verification and validation knowledge, which supports the end users to identify and to avoid system errors like deadlocks, and determines the model coherence according to the real world. The objectives of this research are (1) complementing the existing modeling methods and tools for verification of construction process models according to the behavioral and structural properties and (2) structuring the templates and instructions of the verification and validation processes with knowledge acquisition to improve the user's abilities.



Process Verification Framework and the detailed Verification Process with Process Patterns

Approach

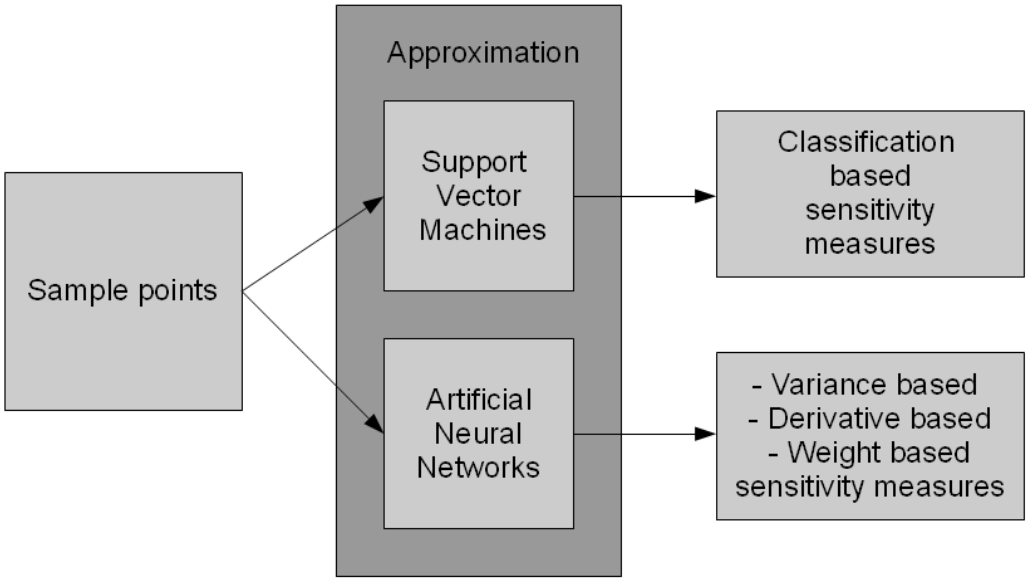
The main focus of this research is creating process patterns in the process verification framework using Petri Nets (PN) analysis in order to verify Business Process Models (BPMs). PN, which is a mathematical and computational modeling language, is the selected method for the verification and validation purpose. It gives system designers a capability of analyzing the models with matrix representations, and it allows modeling of concurrency, synchronization, and resource sharing behavior of a system. The PN model will be represented in PNML for handling in existing PN tools to analyze and to verify the properties of the model. Process patterns can be defined as the set of activities, actions, work tasks or work products and similar related behaviors for developing object oriented software. Process patterns are common or general solution for a complexity. At first there would be defined three main types of process modification patterns, which are analysis patterns, review patterns and consequence patterns. According to the patterns in case of an ill-behaved model in the review phase, the designer can introduce results and modify the process according to the experiences (knowledge acquisition) and check it again. In case of an ill-behaved model in the consequence phase, the designer can introduce the results and modify the process with a new experience. In case of a well-behaved model in analysis phase, it is handed over directly to respective process simulation tools. However in the case of a well-behaved model in review phase, model dispatches to the beginning of the analysis phase. This research work is part of the mefisto project.

Classification based sensitivity measures for efficient optimization in design process

Zeeshan Mehmood, Uwe Reuter

Objectives

An optimal design of structure requires a computationally expensive optimization process. The structural response is often dependent on a number of design parameters, so as the optimization process. The complexity of the optimization problem can be reduced if the relationship between the design parameters and the model response is effectively identified with the help of the methods of sensitivity analysis and only sensitive parameters are then considered for optimization process. Sensitivity analysis helps in identifying the most significant model parameters affecting a specific model response. The objective of this research is to evaluate and develop methods for the global sensitivity analysis of non-linear models in order to facilitate the optimization of a structural design.



Meta-model based process for sensitivity analysis

Approach

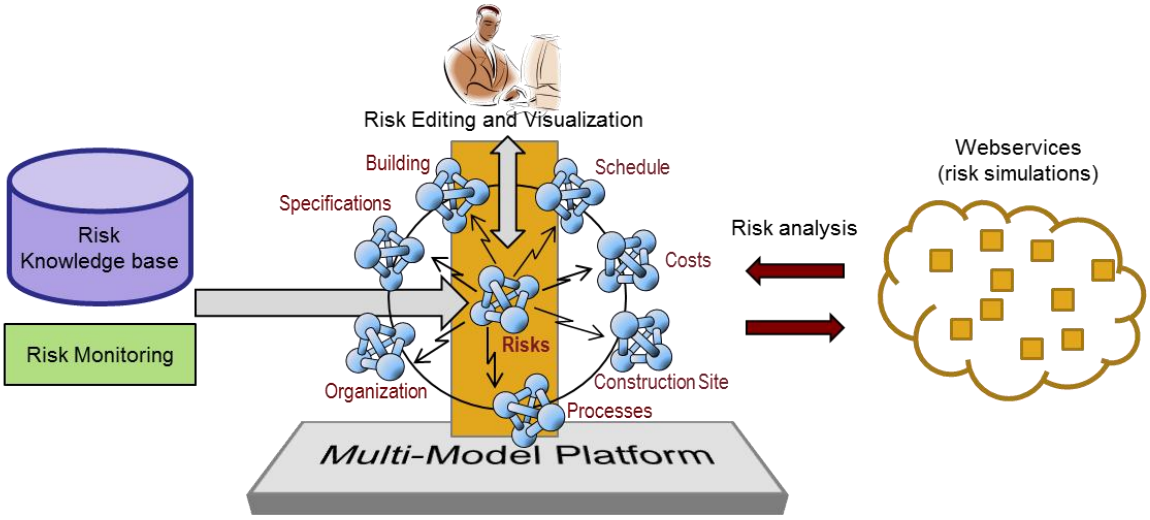
The practical implementation of already existing variance based, weight based and derivative based sensitivity measures requires meta-model based approximation of the structural response for the given structural data. These sophisticated sensitivity approaches provide results in a computationally expensive manner. In this research, the meta-model based approximation process is reduced to classification of the structural data at certain levels of the structural response and classification based sensitivity measures are sought. The sensitivity is assessed by means of change in classification level in structural response. Classification based sensitivity analysis can be performed using Support Vector Machines (SVMs). Nonlinear SVMs perform classification by transforming the input space in a higher dimension space using kernel functions. In addition to change in class level, properties of the kernel functions and the discriminating hyperplanes in the higher dimension can also be exploited for calculating sensitivity information. Sensitivity analysis with classification models is likely to be less computationally expensive and can be easily applied to the relevant industry problems. This research work is part of the EGSA project.

Risk Modeling and Management using Multi-Models

Hervé Pruvost

Objectives

Managing risks in a construction project is a necessary process that has to be accomplished continuously throughout all project phases. Risks affect all domain models like Building, Process or Schedule models, and have effects in term of costs, time and quality. Four essential steps have to be executed in a dynamic way as parts of a risk management cycle comprising risk identification, risk analysis, risk treatment planning and risk monitoring. Risk identification performs an exhaustive listing of all possible threats, their categorization, and the recognition of the affected models instances as well as of risk chains. Risk analysis enables the evaluation and prioritization of risks with help of risk simulations. Risk treatment planning consists of determining preventive measures and reaction strategies to reduce threats to the project objectives and to enhance reactivity. Within the execution phase of the project the risk monitoring and control task continuously reevaluate the suitability of the planned treatment measures and support identifying new emerging risks. Risk management has to be carried out by every project actor like the owner and the general contractor according to their own interests and objectives.



Integration of the risk model in the Multi-Model platform

Approach

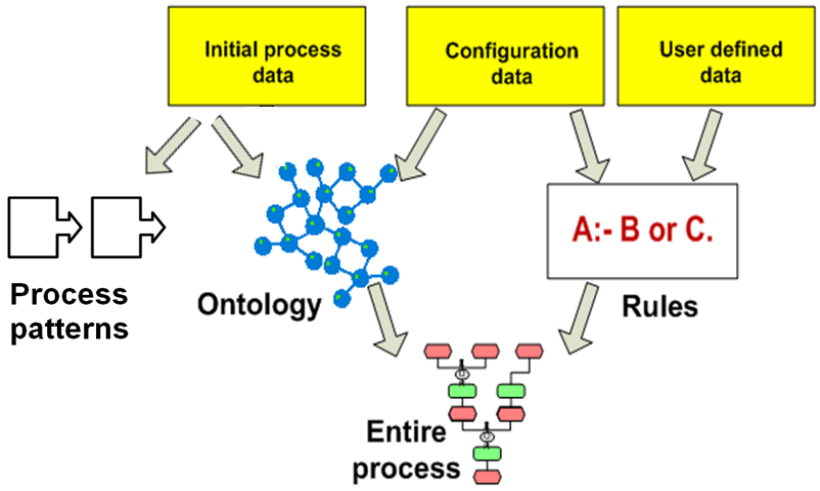
The methods being developed in this work aim at modeling and managing risks through an existing Multi-Model Platform. This approach will significantly enhance risk management efficiency by allowing interoperability, comprehensiveness and dynamics. A risk model can be created by the user and populated with relevant risk data from a knowledge base that suit the current project state. The model can be edited through an editor integrated in the platform letting the user filter, sort the data, and insert his own risk information to create a consistent risk list. Risks can be associated to all affected project objects such as construction processes or building parts, and risk chains are automatically identified using the objects hierarchies and relations existing in one model as well as through different models. The product of the risk identification is then stored in a Multi-Model Container that uses standard exchange formats enabling on demand data import in different kind of simulation applications (cost simulation, schedule simulation,…) accessible through a web service. The risk information will be actualized by simulation results that help planning proactive and reactive measures with support of measure and process change templates from the knowledge base. User's objectives and preferences can also be registered in the risk model to better support decision making. The risk information is continuously updated by new identified risks from the risk monitoring, the knowledge base and the user himself, combined with new project plans, and complemented by results of risk simulations, enabling to dynamically reevaluate, prioritize, and treat risks all along the project. This research work is part of the mefisto project.

Ontology and Rule-Based Business Process Analysis and Planning

Ksenia Roos

Objectives

Construction companies are increasingly interested in describing and saving internal process knowledge in project neutral and modular form. This can be done with the help of process patterns or process modules that can be further used for fast and reliable process planning and analysis. As such, process patterns promote systematic reuse of proven or common practices. The hypothesis of this research is that an ontology knowledge base representing business process patterns with related construction data can provide a collaboration model with clear and unambiguous semantics, thereby facilitating integration and reuse of existing best practice business processes and data models. Formalization of the processes in ontologies and using ontologies within large projects with many heterogeneous resources has multiple advantages. By means of ontologies flexibility, interoperability and more efficient process management and analysis can be achieved. Today process planning is mainly done manually or at best on the level of IT supported scheduling. This requires a significant amount of work to create, adapt and maintain the business processes. An automated procedure realized by means of ontologies and enhanced with additional process rules can be much more effective, enabling the combination of a set of adapted process patterns into a consistent higher order process.



Principal business process analysis and planning by means of patterns (modules), ontologies and rules

Approach

In the Semantic Web's layered structure, it is still an open question whether or not there should be only one homogeneous hierarchy for using rules together with ontologies. However, a clear benefit of using rules with an ontology is the ability to close the domain at will and to succinctly represent knowledge that is not trivially expressible using only an ontology knowledge base. The construction process patterns, represented in one of the acknowledged process modeling languages (BPMN, EPC) can be beneficially formalized in an OWL ontology. Complex knowledge can be represented using the *drools planner* with its rule format. The formalization succeeds by using three kinds of data.

- *configuration data* that provides a set of non-ground rules defining the relationships between processes;
- *initial process data* that provides a set of ground facts defining what process patterns and construction data are available and what relationships they have with other processes and their data;
- *user defined data* that provides a set of ground facts telling what properties (or strategic values) the user wants the entire process to have.

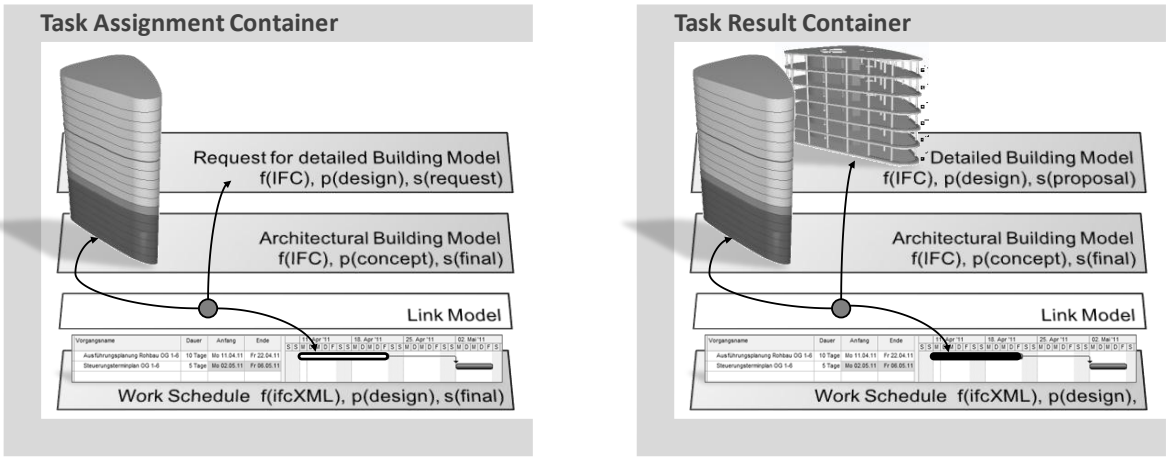
The prototype implementation is based on a Java framework which builds upon the described principal concepts. It will serve for dynamic process analysis and intelligent planning on the basis of process modules and will support process management by providing high-level reasoning capabilities. This research work is part of the mefisto project.

Process-driven Management for Multi-Model Creation and Reuse

Sven-Eric Schapke

Objectives

With the increasing utilisation of model-based planning and controlling information, there is a need to compare, combine and integrate different engineering and management models used in a construction project. In the Mefisto project existing AEC software applications have been extended to support the interlinking of such application models and a neutral container format was defined to exchange the resulting multi-models. The developed technologies allow for new ways of planning and decision-making on distributed, yet interdependent application models. In contrast to a central project model or data base multi-models are first created locally combining selected project information of different disciplines and project phases to support specific planning or controlling tasks. The objective of this research is to develop complementary process management technologies to coordinate the creation and reuse of multi-models throughout the organisation of a construction project. By sharing the multi-models among the project participants, synchronization points can be established that provide well-defined snapshots of the overall project information and a basis for subsequent project planning, controlling and communication tasks.



Two multi-model containers (1) for assigning the workflow task "design of concrete structure" and (2) for delivering the respective design results

Approach

Starting point of the research was a scenario matrix documenting several scenario analyses that examined the required content of multi-models for over 100 different engineering and management tasks. Based on the developed multi-model descriptions a semantic vocabulary was defined as part of a *Project Collaboration Ontology*. The vocabulary allows for the annotation of application models within a container in regard to their domain (d), data format (f), subject matter (m), level of detail (l), project phase (p) and status (s). Moreover, the vocabulary can be used to define respective multi-model templates (MMTs). Using such MMTs and the Business Process Modelling Notation (BPMN) process models are developed for selected use-cases scenarios. They represent reference models that can be used for managing the creation and reuse of multi-models in four steps. Firstly, the reference process models are configured for specific project refining tasks, responsibility and MMT specifications. Secondly, the BPMN models are converted to a process formalisation developed on the basis of ifcXML 2x4. Thirdly, workflow configurations are performed in extension to a given project schedule by integrating modelling concepts of scheduling, business process modelling and multi-models. For executing the workflows, a management service is finally planned that uses the schedule information to visualise the workflows as well as to support their coordination as illustrated in the above figure. On the left side, the figure depicts a multi-model container requesting a detailed design for the concrete structure of a high-rise building. It interlinks a work schedule with a building section in an architectural model as well as a template for the detailed 3D model to be designed. The result container on the right side comprises an updated work plan as well as the building models of the architectural and the detailed concrete structure. The research work is part of the mefisto project.

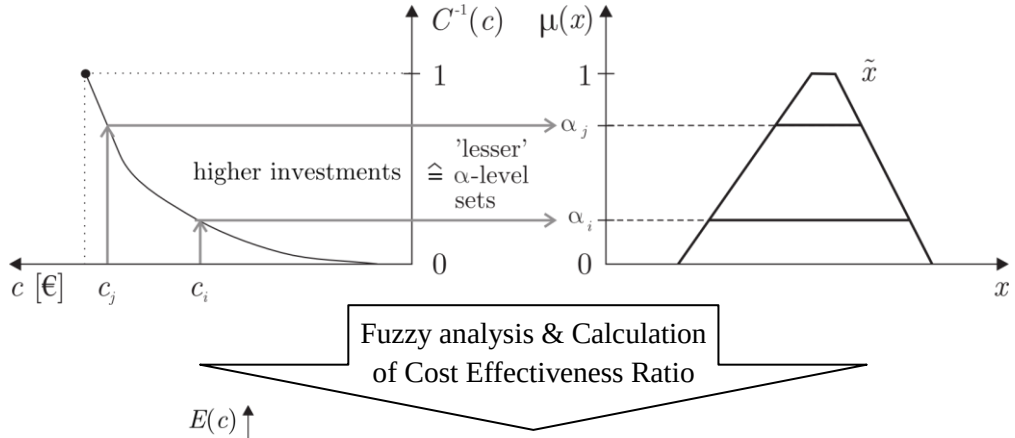
Supporting Decision Making in Context of Risk Measures: Cost-Effectiveness Fuzzy Analysis

Ulrike Schirwitz, Uwe Reuter

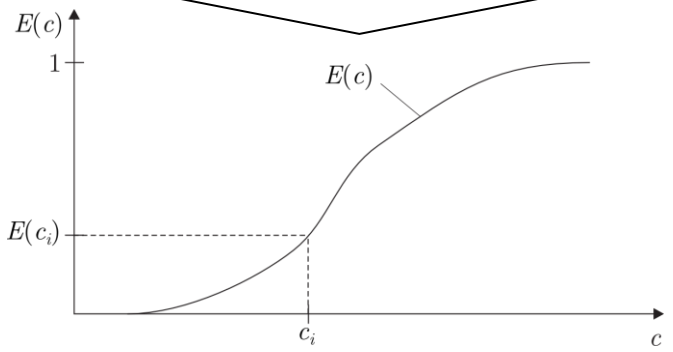
Objectives

Many production processes are characterized by risks and therefore by uncertain data and information. Risk management is an important part of each building project. After identification of all project relevant risks they have to be treated in different ways. It has to be examined whether and how it is possible to track, to reduce or eliminate risks by additional measures. Usually such measures involve additional monetary investments. Furthermore there are risks that can be treated by multiple measures. That means a decision has to be made for each risk which of the measures is recommendable or if the risk will be treated otherwise. Hence methods and tools are necessary to support this decision process. One important criterion for rating different measures is the cost-effectiveness. For a sensible decision making the influence of all possible measures on the risk and finally on the building process has to be evaluated and compared.

(a)



(b)



Mapping of investment costs onto uncertain input variable (a) and result "Cost-effectiveness diagram" (b)

Approach

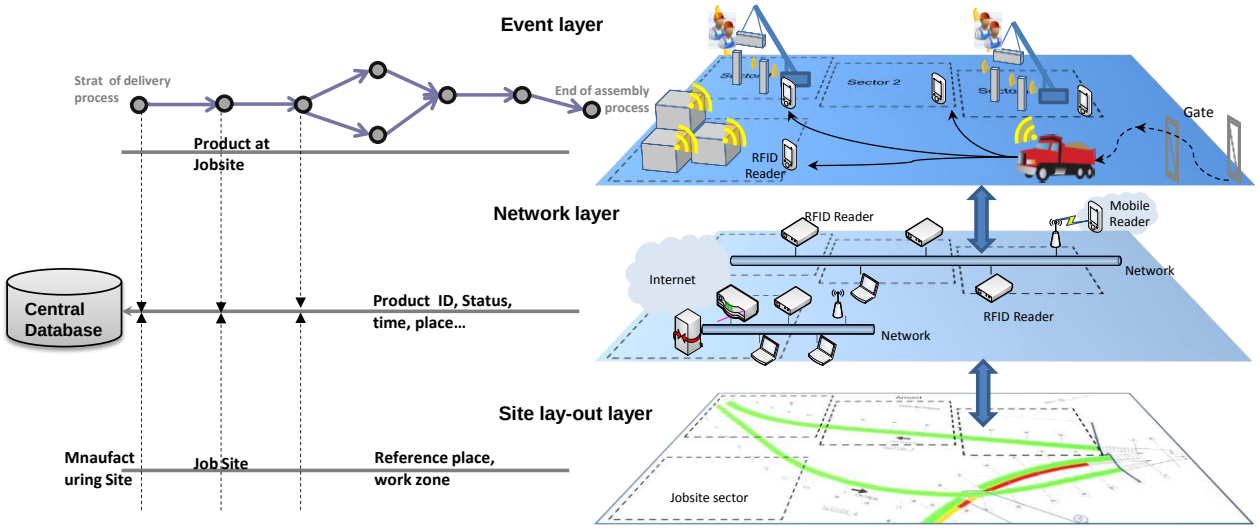
The approach is the combination of the cost-effectiveness analysis and the fuzzy analysis as cost-effectiveness fuzzy analysis. In context of decision making about suitable risk measures this shall be further analyzed. The cost-effectiveness analysis is a method for evaluating several courses of action and for supporting decision making in the field of investments. It does not determine the benefits as monetary values, but in any other unit, in the present context as reduction of uncertainty. Fuzzy analysis is a method which enables uncertain terms to be handled in form of fuzzy variables. Aim of the cost-effectiveness fuzzy analysis is the evaluation of the effectiveness of monetary investments on the reduction of uncertainty of the analyzed values and therefore the reduction of risk. A multi-model comprising a time model linked with a risk model at least can provide the input data for the analysis. An important point is the mapping of investment costs onto different α-levels of the uncertain input variable (see figure (a)). That expresses the influence of the investment onto the uncertainty of the input variable and is a basis of the fuzzy analysis, which is followed by a cost-effectiveness analysis. Result of this approach is the cost-effectiveness ratio. Methods for a suitable evaluation and presentation, e.g. in form of cost-effectiveness diagrams (see figure (b)), of these results have to be examined. This research work is part of the mefisto project.

Using RFID Technology to Support Real Time Monitoring of Construction Processes

Yaseen Srewil

Objectives

Current field practices at construction sites still rely on manual processes for asset tracking and information handling. The result is that the information of construction processes, process states and resource are often incomplete and unavailable on time. Therefore, there is an information gap preventing efficient process planning, delays in the execution of tasks and inefficient productivity on site. The Radio Frequently Identification technology (RFID) has a high potential to bring great benefits in construction industry to bridge this gap through improving real-time information, visibility, traceability, and continuous monitoring. Thanks to its excellent features for the identification of static or even moving products, machines and personal in harsh environment conditions and at economic level, Ultra High Frequency (UHF) RFID system will be used in this research. The objective of this research is to explore the implementation of RFID technology in construction processes to improve the control and real time monitoring of construction projects. This research proposes to use UHF RFID technology to enable real time monitoring of prefabricated FRP bridge components as well as update their status automatically (be delivered, stored, assembled on site…). Furthermore, this study will discuss a primary system for automated execution of construction process, on site assembly processes and resources management.



The concept system of embedded UHF RFID technology in product identification in construction project

Approach

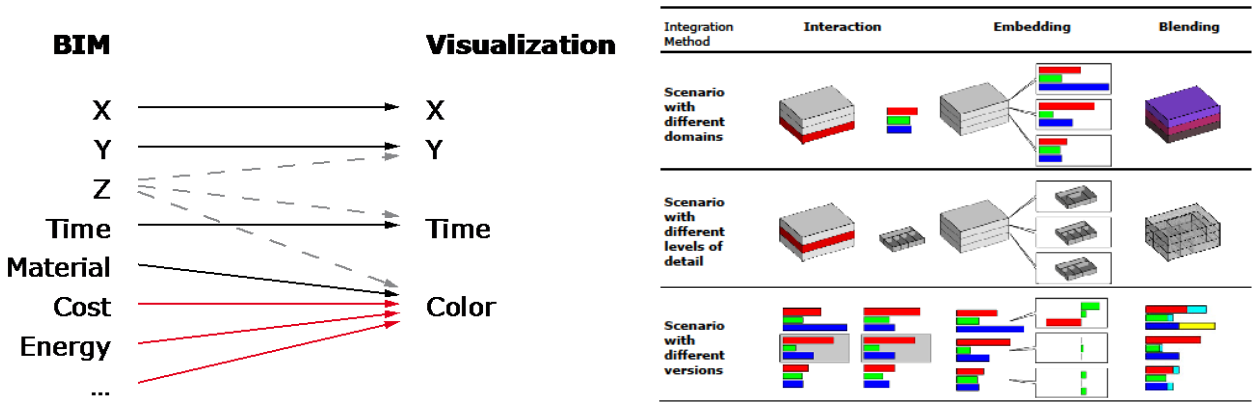
To allow continuous monitoring of all relevant building components and resources throughout all construction phases a methodology is required for detecting their positions and their states undisturbed, automated and in real-time. This approach considers the three characteristic layers of the construction sites: (1) Event layer representing the construction process, (2) Network layer for the mapping of events from the event layer to network configurations to make them tractable and (3) construction site layer, which maps the network device configurations to their corresponding physical locations. Research starting point is the structuring of the construction site into work zones (sectors) to update the state of the products easily (at least; at jobsite gate, store or lay down area, crane at assembly site). These places are mounted with RFID reader. According to this approach, the information gathered with the RFID system (Product ID, Product status, Place…) at each process level, serves the purpose to keep the process information continuously updated and to enable an early stage alternative planning. This information enables project managers, site engineers and foremen at jobsite to check the status of the product, update it and add their note. In addition, the resources (product, machine and personal) can be monitored on/off construction site at real-time and reallocated where necessary to meet new requirements. This research work is a part of the Trans-IND project.

Towards a Configurable nD-Viewer for Building Information Models: a Formal Model for the Description of Visualization Mappings

Helga Tauscher

Objectives

Given the ongoing success of model-based tools and software applications, the continuous application of model-based workflows will be increasingly requested in the next years. With the shift of paradigm towards model-based work, information and presentation are decoupled. Visual representations, previously implicitly contained in exchanged documents and drawings, are then only generated on the fly and on demand. However in order for graphics to fulfill their communication means, there is a need for explicit, reproducible descriptions of visualization methods. Such a description does also allow for the development of customized reusable visualization components. The advantages of reusable visualization components are twofold: the same visualization can be applied to many information models and moreover a rich repository of customized task specific components allow for the better exploration of the models.



(1) Common mapping from extensive information model to limited visualization model, (2) integration methods

Approach

Based on the visualization pipeline as a reference model for the visualization process, the central mapping and transformation step from a filtered and prepared domain model to a renderable visualization model can be identified as crucial. Therefor the work focuses on this step and the development of a generic model for this mapping process, which should cover all possibilities for the mapping. To achieve this, two complementary approaches will be taken:

First, the exploding dimensions on the building information model side are explored and contrasted with the limited dimensions on the visualization model side (Figure 1). These limitations are due to the nature of human perception on the one hand and due to the technical preconditions of the selected medium on the other hand. By studying these resources of human computer interaction (HCI), the economics of visualization mappings will be revealed and the boundaries of the potential mapping space can be analyzed.

In parallel a bottom-up approach will be taken, which analyses concrete visualization methods in terms of their input data, their usage of the visualization dimensions and the transformation process between the two sides. Well-known visualizations (e.g. color-coded 3d presentations or schedule-based animations) as well as new, experimental visualizations (e.g. area-by-value cartograms) are taken into account for this step.

The analysis of the low level visualization building blocks will be complemented with the combination of multiple elementary visualizations into compound visualizations (Figure 2).

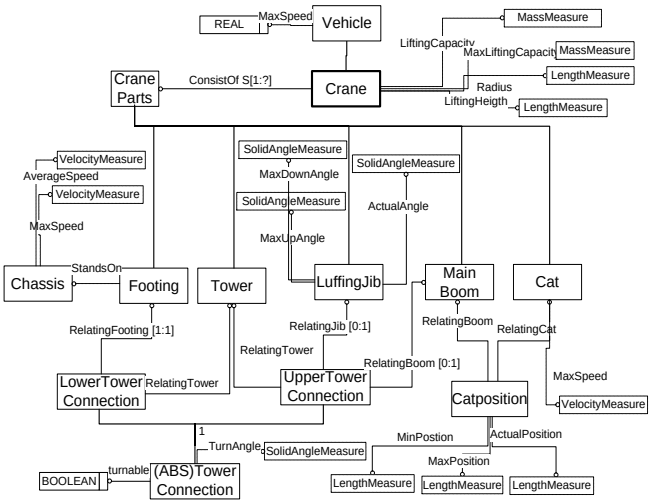
The parallel bottom-up approach allows for the early implementation of practical use case scenarios, the early verification of the objective hypothesis and will later provide a solid base of examples for the application of the envisaged generic visualization description language. The research work is carried out as part of the mefisto project.

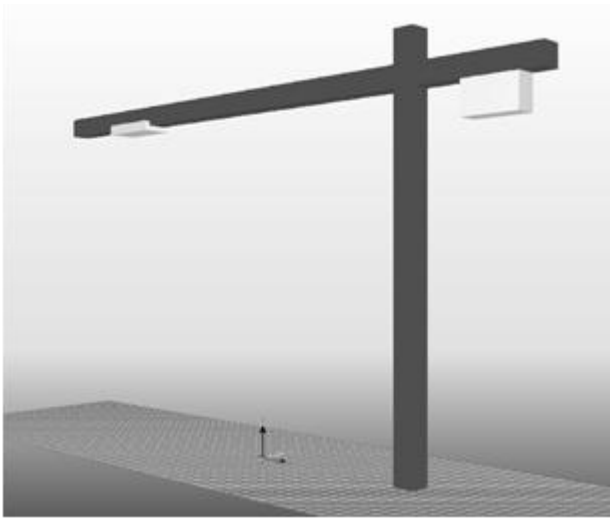
4D Construction Site Viewer Based on a Hierarchical IFC conform Model

Ulf Wagner

Objectives

To enable integrated IT-supported planning and realization of construction projects, it is necessary to design construction sites at the computer and exchange the resulting information models in digital way. Today, there are several software tools available for construction site modelling. However, often they do not integrate well with common 3D CAD programs and they do not provide for a qualified data exchange with other tools. Most often the existing construction site modellers support the visualization of the construction site equipment but they offer little functionalities to simulate the construction site processes and to prove the practicability of the planned processes, e.g. checking possible collisions of cranes, supply chain bottlenecks, storage area availability etc. The objective of this research is to develop a 4D construction site viewer that allows for the visualization of predefined animation paths as well as interactive animations. The animation paths will be preferential for workflow and production simulation proofing. With the help of user-interactive animations collision checks can be done. The viewer shall be available to normal end-users without special simulation training.





IFC-based Construction Site Model *Context sensitive Visualization*

Construction Site Equipment Model Viewer

Approach

The IFC model is a common data standard that is supported by most CAD programs for the exchange and sharing of building models. In our research the IFC schema is extended to also represent construction site elements such as construction equipment and materials. Moreover, site infrastructure elements such as roads, gateways, utilities and pipes are considered. Overall, the IFC construction site model is kept as simple as possible, complementing available IFC geometrical representations with only a few essential classes and attributes. To support more complex planning tasks such as animations, simulations and collision checks an additional library of detailed equipment models is developed. Within that library the IFC model data are complemented with more detailed geometrical information, kinematic and performance descriptions as well as respective cost data. The realization of the 4D construction site viewer is based on three essentials aspects:

(1) The description of construction site models in correspondence to the IFC standard, so that the construction site elements can be visualized and utilized within different viewers and CAD programs;

(2) The description of the animation paths separately from the IFC construction site model (thus, the construction site models remain static models that only hold the positions of construction site elements at a certain point in time while their movements are captured within external XML-based time diagrams or tables);

(3) 4D IFC viewer with an integrated animation component developed on the basis of the available open source viewer provided by the Open IFC Tools.

This research work is part of the German *mefisto* project.

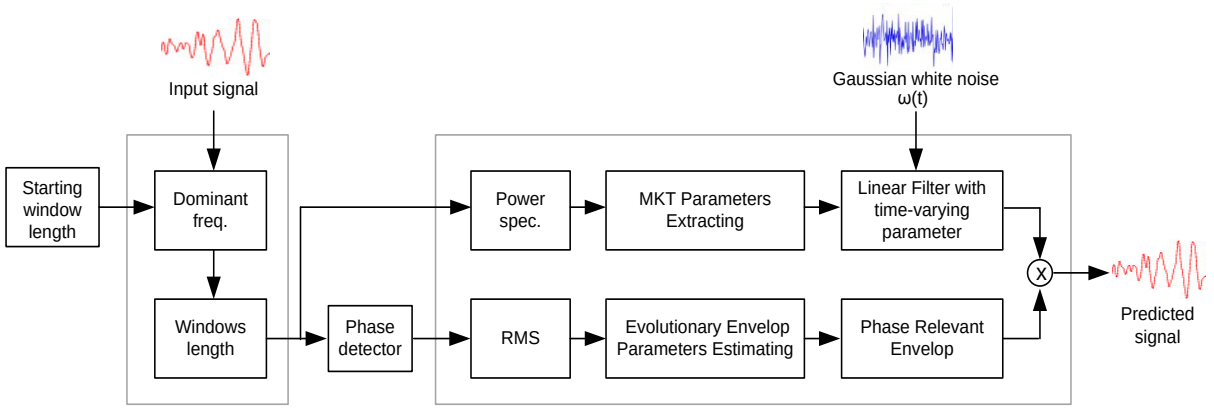
A Stochastic Real-time Wave-type Based Model for Prediction of Strong Ground Motion Accelerogram

Amin Zahédi Khaméneh

Objectives

A wave type based method for real-time prediction of strong ground motion (SGM) accelerogram is developed. Real-time prediction of SGM is requested in predictive building control systems to compensate the time delay, which occurs during processing of measured information and in executing the control forces. The time delay might cause unsynchronized application of the control forces and this unsynchronization can not only render the control ineffective, but may also cause instability in the system.

It is well known that SGM is a classic example of non-stationary stochastic process with temporal variation of both amplitude and frequency characteristics. In the suggested real-time predictor the non-stationarity is achieved by splitting the process in its dominant phases, namely P, S and coda. Additionally, separating the temporal amplitude and spectral non-stationary characteristics of the process increases flexibility and ease in modeling and parameter estimation. The temporal stochastic evolutionary process of amplitude is modeled by using an exponential wave type based envelope function which was suggested by Shinozuka and Sato. In order to model spectral amplification of several layers and/or modes of resonance, multi Kanai-Tajimi filter (multi-KTF) proposed by Bretschneider and Scherer is used.



The components of the stochastic real-time predictor

Approach

In order to detect the dominant phase a stochastic principal component based model which was developed by Scherer et al is used. It is shown that changing of the angle between the first stochastic principal component and the vertical axes in a Cartesian coordinate system can illustrate reliably changing of dominant seismic wave phase. The real-time predictor model parameters will be identified by matching the model to the target accelerograms. The envelope function described through three parameters which are related to variables that directly present the physical properties of an accelerogram. The parameters of the amplitude envelope are estimated by using the rising gradient and upon availability position of the envelopes peak. The dependency between envelope rising gradient and the position of peak value is modeled by use of stochastic artificial neural networks. Performance of the proposed model is verified by the use of strong ground motion records of Northridge (1994), which are selected upon the soil types of C and D according to Eurocode 8. The most significance of the proposed model is the concept of wave type based modeling which has the advantage of a conceptual physical modeling of the seismic process furthermore in spite of the common non-stationary modeling methods, which has a single envelope function, the suggested SGM predictor model is extended to the most important wave types which more precisely reflect non-stationarity of seismic process as well as in time and in frequency domains.

Research Contracts

Title: **mefisto – A model, information and knowledge management platform in AEC**
(mefisto – Eine Modell-, Informations- und Wissensplattform im Bauwesen)
www.mefisto-bau.de

Project Leader: Prof. Dr.-Ing. R. J. Scherer
Co-leader: Dr.-Ing. P. Katranuschkov, MSc S.-E. Schapke

Financial Support: BMBF (German Ministry of Education and Research)

Budget/Funding: 16.1 million Euro/9.4 million Euro (total), 1.5 million Euro (CIB)

Duration: 3 years, since 4/2009, applied for extension

Approach: **mefisto** is a BMBF lead project in construction ICT that aims at developing a framework and a visual platform for the management of the multi-model world of construction projects based on a process-centric approach. It defines a structured set of information models subdivided into several layers with regard to the represented information (1: building product, construction site, construction organisation, 2: work grouping, schedules, costs, 3: risks and uncertainties, 4: several ontologies). Interoperability of the modelling data will be achieved via a common platform ontology, the newly developed multi-model container concept, capturing various process-related views, and a set of interoperability services achieving the needed filtering and mapping data transformations both horizontally (between different models on one and the same level of abstraction) and vertically (to/from the different levels of abstraction within one model schema, thereby enabling appropriate information aggregation and expansion). These interoperability services will be embedded in an overarching process management approach providing for dynamic definition and run-time application of process modules on the basis of reusable reference process patterns incorporating compositional, contextual and strategic knowledge. Using these newly developed process configuration method and services as well as available sophisticated systems for construction management, controlling, geometry modelling and simulation, which will be extended in the frames of the project, mefisto will achieve:

- Flexible and efficient construction site configuration
- Process representation and information views on different levels of granularity
- Semi-automatic creation of simulation model so that simulation tasks can become affordable not only to large-scale projects
- Semi-automatic conflict detection by various logistics and construction tasks
- Prognosis and risk management
- Integrated controlling and management, bridging the gap between contractor and client but at the same time observing contractual and security constraints.

From ICT point of view the overall system will be an open, distributed modelling and service framework enabling plugging-in of third-party tools both locally, as extension of available systems, and centrally, as commonly accessible web services. Special attention will be paid to the development of various innovative visualisation techniques to enable efficient navigation and examination of different aspects of the multi-model project world, such as 4D and 5D viewing/navigation, topological views, cockpit functionality for display of critical values and visualizations of abstract networks resulting from costs, time, risks, and other interdependent models etc.

Partners: TU Dresden, Institut für Bauinformatik – **Coordinator**,
AEC3 Deutschland GmbH (München), Ed. Züblin AG (Stuttgart),
gibGREINER GmbH (München), Max Bögl Bauservice GmbH (Neumarkt),
RIB Software AG (Stuttgart), SimPlan AG (Maintal), Solidpro GmbH (Langenau),
TU Dresden: Institut für Baubetriebswesen, Institut für Software- und Multimediatechnik, Bauhaus-Universität Weimar: Professur Baubetrieb und Bauverfahren,
Ruhr-Universität Bochum: Inst. für Informatik im Bauwesen

Title:	**HESMOS – ICT platform for holistic energy efficiency simulation and lifecycle management of public use facilities** www.hesmos.eu
Project Leader:	Prof. Dr.-Ing. R. J. Scherer, Co-leader: Dr.-Ing. Peter Katranuschkov
Financial Support:	EU – EC FP7, EeB.ICT.2010.10-2 – ICT for energy-efficient buildings and spaces of public use
Budget/Funding:	4.6 million Euro/2.7 million Euro (total), 0.6 million Euro (CIB)
Duration:	3 years, since 9/2010
Approach:	**HESMOS** develops an industry-driven holistic approach for sustainable optimisation of energy performance and emissions (CO2) reduction through integrated design and simulation, while balancing investment, maintenance and reinvestment costs. The objective is to close the gaps between existing intelligent building/facilities data so that complex lifecycle simulation can easily be done in all design, refurbishment and retrofitting phases where the largest energy saving potentials exist. This is achieved by (1) extending the existing standard Building Information Model (BIM), energy simulation and cost calculation tools, so that they can seamlessly exchange the required data, (2) integrating advanced energy simulation tools into the design and FM process, so that BIM-CAD and FM tools can be used as building energy simulators and gap identifiers, (3) developing new applications that can visualize building performance in easy to understand way and can quickly display impacts of changed building/space parameters, (4) developing new "cockpit functionality" in BIM-CAD on EPBD basis to provide fast feedback of the impact of design parameters on lifecycle energy performance, (5) extending BIM-CAD to model and manage buildings and surrounding areas, and (6) integrating BIM and Building Automation System data and querying these multi-model data with the help of a high-level easy to understand engineering language. The final product of HESMOS will be an Integrated Virtual Energy Laboratory (IVEL) enabling comprehensive studies of design and retrofitting alternatives concerning energy performance and total costs. To achieve that, an innovative SOA around the kernel functionality of BIM-based CAD/FM is applied. Information interoperability is provided by enhancing BIM with multi-model energy and emissions features to a new sharable eeBIM. Intelligent access methods and a specialised ontology are developed to enable multi-system integration and management of material, climate and product databases and data from sensor networks and other ICT sub-systems into CAD/FM. To validate the research results and expedite their uptake in practice, an extensive 30-month validation programme at two PPP projects (a professional school complex in Pforzheim and an office building in Kassel, Germany) has been carried out during the project.
Partners:	TU Dresden, Institut für Bauinformatik – **Coordinator**, TU Dresden, Institut für Angewandte Informatik, Institut für Bauklimatik Nemetschek Slovensko s.r.o. (Slovakia), Olof Granlund Oy (Finland), BAM Utiliteitsbouw n.v. (The Netherlands), BAM Deutschland AG (Stuttgart), Obermeyer Planen + Beraten GmbH (München), AEC3 Ltd. (UK)

Title:	**ISES – Intelligent Services for Energy-Efficient Design and Life Cycle Simulation**
Project Leader:	Prof. Dr.-Ing. R. J. Scherer Co-leader: Dr.-Ing. Peter Katranuschkov
Financial Support:	EU
Budget/Funding:	4.4 million Euro/3.0 million Euro (total), 0.6 million Euro (CIB)
Duration:	3 years, expected start 11/2011
Approach:	The objective of **ISES** is to develop ICT building blocks to integrate, complement and empower existing tools for design and operation management (FM) to a Virtual Energy Lab. This will allow evaluating, simulating and optimizing the energy efficiency of products for built facilities and facility components in variations of real life scenarios before their realization. A special aspect is the stochastic modelling of the life-cycle. The focus of the prototype application domain is on buildings, factories and warehouses because in buildings about 40% of the global energy is used and 30% of CO_2 emissions and solid waste is created. There is a huge market for more energy-efficient design of new buildings and for refurbishing of the huge building stock through energy-efficient component products. The goal of the project is to increase, by an order of magnitude, the quality of energy-efficiency in design through the development of an In-Silico Energy Simulator Laboratory, based on an interoperable ontology-supported platform and customizing Grid and Cloud researches. The focus of research is on multi-model design and testing, stochastic lifecycle analysis/simulation in combination with new supporting ontology and interoperability tools and services, and respective re-engineering of existing tools, making them more intelligent and smartly interoperable. Further goals are the combination of energy profile models with product development STEP models and building and facility BIM models. The developed Virtual Energy Lab will be an extension of the platform achieved in the HESMOS project. It will be configured as an ontology-controlled SOA system with distributed services, distributed modelling and analysis/simulation tools and distributed data sources. This will allow concentrating the RTD work on ICT gaps, whereas existing, market-proof services, tools and data sources can be incorporated nearly development-free.
Partners:	TU Dresden, Institut für Bauinformatik – **Coordinator**, Olof Granlund Oy (Finland), University of Ljubljana (Slovenia), Nyskopunarmidstod Islands (Innovation Center Iceland), SOFiSTiK Hellas S.A (Greece), National Observatory Athens (Greece), Leonhardt, Andrä und Partner (Germany), Trimo d.d. (Slovenia)

Title:	**SARA – Coupled structural/aerodynamic analysis and control of wind-induced loads on civil engineering structures** *(Gekoppelte Fluid-Struktur-Analyse und -Kontrolle windinduzierter Lasten auf Bauwerke des Ingenieur- und Hochbaus)*
Project Leader:	Prof. Dr.-Ing. R. J. Scherer Co-leader: Dr.-Ing. Peter Katranuschkov
Financial Support:	EU – Eurostars Nr. E14797; BMBF (German Ministry of Education and Research)
Budget/Funding::	1.3 million Euro/0.9 million Euro (total), 0.3 million Euro (CIB)
Duration:	3 years, since 3/2010
Approach:	Accounting for the wind-induced loads on a structure, Eurocode 1 regulations (EC1) are routinely used by commercial structural analysis software. However, in the case of artistic architectural designs involving complex building shapes, EC1 provides only rough approximations. It goes through the use of very general assumptions, since it mainly refers to applications with simple geometries. In addition, only integrated loads on structures can be obtained, but not load distributions. Whenever accurate and detailed calculations are needed for the wind-induced loads to the structure, costly experimental studies in wind tunnels have to be performed. Consequently, in order to make informed design decisions a large number of models with various sets of parameters have to be tested. Hence, what happens by routine designs is that the structure is often over-dimensioned by means of qualitative and/or heuristic use of EC1 guidelines. However, in the case of elastic structures, over-dimensioning against static loading does not guarantee their safety against extreme, dynamically varying real wind loads. The innovation of the SARA project lies in (1) the use of a real Building Information Model (BIM) from design, (2) the semi-automatic generation of the structural analysis and dynamic wind loading models, (3) a numerical tool for the simulation and calculation of the structure's response to wind-induced loads, and (4) a BIM management system for the handling of model variations and simulations. Special emphasis is put on the case of tall buildings where wind phenomena are most important. The product of the research will stand for "numerical wind tunnel", where possible modifications during the design stages can be easily and without costs incorporated into the structural model, load distributions can be obtained along the structural members, and elastic structures of arbitrary geometrical complexity can be analysed. Furthermore, the proposed methods will be applicable for the assessment of mechanisms and shape design techniques aiming to control wind-induced vibration and improve the performance of tall buildings to it. Thus, the impact of wind-induced loads to the architectural design, as well as measures to alleviate undesired building responses, can be incorporated in everyday design work, replacing for most design stages the costly wind tunnel experiments.
Partners:	SOFiSTiK Hellas S.A. (Athens, Greece) – **Coordinator**; Wacker Bauwerksaerodynamik GmbH (Birkenfeld, Germany); TU Dresden, Institut für Bauinformatik

Title:	**Trans-IND – New industrialised construction process for transport infrastructures based on polymer composite components** www.trans-ind.eu
Project Leader:	Prof. Dr.-Ing. R. J. Scherer
Financial Support:	EU – EC FP7, GA NMP2-LA-2009-229142
Budget/Funding:	9.8 million Euro/6.1 million Euro (total), 0.2 million Euro (CIB)
Duration:	4 years, since 6/2009
Approach:	Polymer based manufactured components for construction applications have been designed, developed and demonstrated in several European projects such as HP FUTURE-Bridge, SAFEFLOOR and MEGAWIND. The findings of these projects have been very promising with regard to customer requirements, quality, technical and economic feasibility and the favourable impact of using this kind of composite-based components in terms of sustainability, safety and quality of life. However, there is still a need to industrialise the whole construction process of the Fibre Reinforced Polymers (FRP) components in order to achieve real practice results. Furthermore, integration of the entire supply and value chain is needed, as well as the development of a high technology for design and manufacturing of FRP components, to transform on-site construction to off-site manufacturing. To answer such challenges the European Integrated Project Trans-IND sets out to develop a *cost-effective integrated construction process* based on innovative product and process management methods that will enable the maximum capability of industrialisation of components for transport infrastructures such as road and pedestrian bridges, underpasses, acoustic and safety barriers using polymer based materials (carbon fibre, glass fibre). The project outcomes will be demonstrated, as a pilot case, for components of a bridge (beams, preslabs) due to the high complexity in the bridge components manufacturing and assembly compared to other applications.
Partners:	Mostostal Warszawa S.A. (Poland) – **Coordinator**, Acciona Infraestructuras S.A. (Spain), Advanced Composites Group Ltd. (UK), ASM Centrum Badan i Analiz Rynku Sp. z o.o. (Poland), D'Appolonia S.p.A. (Italy), Fundacion Fatronik (Spain), Fraunhofer-Institut für Produktionstechnik und Automatisierung IPA (Germany), Huntsman Advanced Materials GmbH (Switzerland), Consiglio Nazionale delle Ricerche (Italy); Institut für Verbundwerkstoffe GmbH (Germany), Labein Tecnalia (Spain), MIKROSAM (FYR Macedonia); Semantic Systems S.L. (Spain), TNO (Netherlands), BV machinefabriek van Wees Tilburg (The Netherlands), Universita Politecnica delle Marche (Italy), Gradbeni Institut ZRMK d.o.o. (Slovenia), Solintel M&P S.L. (Spain), Atos Origin S.A.E. (Spain), TU Dresden, Institut für Bauinformatik

Title:	**GeoTechControl – Knowledge-based service platform for monitoring and prognosis of the behaviour of geotechnical engineering structures** *(GeoTechControl – Wissensbasierte Serviceplattform für Überwachung und Prognose Geotechnischer Ingenieurbauwerke)*
Project Leader:	Prof. Dr.-Ing. R. J. Scherer Co-leader: Dr.-Ing. Gerald Faschingbauer
Financial Support:	BMBF (German Ministry of Education and Research)
Budget/Funding::	1.7 million Euro/1.1 million Euro (total), 0.3 million Euro (CIB)
Duration:	3 years, since 7/2010
Approach:	Due to the high uncertainty of the underlying geotechnical models complex construction activities in geotechnical engineering typically require continuous monitoring, frequent adjustment of prediction calculations to the measured actual system behaviour and flexible situation-dependent management of the construction process. To answer that challenge GeoTechControl develops an innovative monitoring and prediction system that will raise significantly the safety and the economic efficiency of geotechnical engineering works by means of a synchronised construction and monitoring process cycle. The use of advanced Web 2.0 technologies will enable continuous performance of semi-automatic system identification to fill in the current gap between sensor data acquisition and their proper just-in-time engineering interpretation. A new system identification method, namely simulation-based system identification will be developed, which demands a knowledge-based representation of the total ICT system to reach automatic generation and control of the simulation cases. Continuously gathered sensor data will be applied for simulation and knowledge based adjustment of the geotechnical models used for proper identification of the actual system behaviour. The parallel evaluation of multiple model candidates using distributed computational and storage resources in a controlled overall workflow will help to minimize total analysis time, enabling the currently impossible feedback between measurements and prognosis. This will provide for purposeful and timely cause-effect diagnosis by occurring differences between as-designed and as-measured data. The improved prediction computations achieved on that basis will enable derivation of reliable control parameters for automated construction processes as well as informed decisions about corrective actions in manually managed construction activities. Hence, GeoTechControl will provide for substantially minimized risks in large geotechnical undertakings.
Partners:	FIDES DV-Partner GmbH (München) – **Coordinator**; Zerna Ingenieure GmbH (Bochum); ELE Beratende Ingenieure GmbH Erdbaulaboratorium (Essen); Bilfinger Berger Ingenieurbau GmbH (Wiesbaden); Keller Holding GmbH (Offenbach); GeTec Ingenieurgesellschaft für Informations- und Planungstechnologie mbH (Aachen); TU Dresden, Institut für Bauinformatik, Institut für Geotechnik

Title:	**eWorkBau – Webservice-based multi-media teaching and learning concept for craftspeople's training in mobile model-based working methods** *(eWorkBau – Webservice-basiertes multimediales Lehr-/Lernkonzept für die bauhandwerkliche Aus- und Weiterbildung für die mobile modellbasierte Arbeitsweise)*
Project Leader:	Prof. Dr.-Ing. R. J. Scherer Co-leader: Dr.-Ing. Gerald Faschingbauer
Financial Support:	BMBF (German Ministry of Education and Research)
Budget/Funding:	1.8 million Euro/1.6 million Euro (total), 0.5 million Euro (CIB)
Duration:	3 years, expected start 01/2012 (approved stage one of the proposal, contract negotiations in progress)
Approach:	The objective of eWorkBau is the development, testing and field trial of an innovative learning concept for construction craftsmen, encompassing the intensive use of new media and educational methods in the new area of mobile, model-based working. It will enable online participation in virtual classrooms, synchronous learning in Blogs, electronic forums and expert knowledge platforms using Web 2.0 technologies. The aim is to prepare German construction craftsmen for the paradigm shift towards model-based working, thereby providing for sustainable growth and competitive advantage of the sector. The overall approach will be developed by the academic partners, supported by experienced workers and trainers from practice. It will be tested on a number of typical practice scenarios. The expected outcome is a Multimedia Learning Concept that enables the acquisition of advanced problem solving and decision making knowledge and skills, grounded on mobile communication and model-based cooperation techniques. Selected software tools will be adapted and extended by pedagogical aspects to provide for enhanced understanding of the educational goals. Focused is especially the work with a BIM database for craftsmen using mobile devices to prepare bidding proposals, bidding calculations, cost calculations and work schedules and to perform efficient progress monitoring and resource planning. The craftsmen participating in the program will acquire knowledge and skills enabling them to use advanced filtering methods and tools to read and extract specific data from BIM-CAD software, as suitable for their purposes. They will be capable of creating a simplified BIM-based model of a construction site, fill it in with information related to their specific tasks and structure their work accordingly, in an efficient goal-oriented manner.
Partners:	Interessengemeinschaft des Heinz-Piest-Instituts an der Leibniz-Universität Hannover e.V. – **Coordinator**; AEC3 Deutschland GmbH (München); Dachdeckermeister Claus Dittrich GmbH & Co KG (Dresden); Handwerkskammer Koblenz; Handwerkskammer Münster; Zentralstelle für die Weiterbildung im Handwerk Düsseldorf; TU Dresden, Institut für Bauinformatik, Professur Psychologie des Lehrens und Lernens

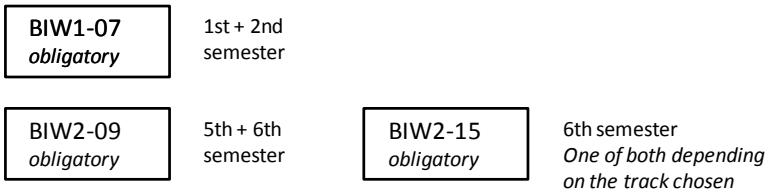
Title:	**EGSA – Evaluation and development of methods for efficient global sensitivity analysis in design process and their realization with an innovative software prototype** *(Erforschung und Entwicklung von Methoden zur effizienten globalen Sensitivitäts-analyse als Grundlage eines innovativen Software-Prototypens im Entwurfsprozess)*
Project Leader:	Dr.-Ing. habil. Uwe Reuter
Financial Support:	European Union (EFRE); Free State of Saxony (SAB)
Duration:	20 month, since 10/2010
Approach:	The optimal design of a vehicle for crash load cases requires consideration of a variety of criteria (design goals), e.g. injury criteria of the passenger and the pedestrian protection, repair costs due to a slow speed collision or partner protection (collision with other vehicles). The simultaneous consideration of different opposite design goals for different load cases (crash scenarios) leads to a very complex multi-layered process. A design engineer has many parameters (theoretically unlimited) to consider in order to achieve an optimal design. Many individual components e.g. geometry (overlapping shapes, cross-sectional shapes, ...), material (strength, yield strength, formability, weldability, ...), parameters of passive safety systems (trigger times of airbags and belt tension systems, sensors, seats, ...) must be determined simultaneously. For the solution of design problems, numerical simulation is often used in addition to the experience based methods. Conditions for the numerical optimization are realistic and therefore very complex mathematical models are inevitable. The numerical and experience-based optimization is in essence an analysis of variants. Every variant of a computational model, which is investigated, represents a possible combination of available parameters. The number of variants to be tested depends mainly on the number of parameters and lies in between more than 10 000 per vehicle project. The calculation time needed to evaluate only a single variant on a high performance computer lies in the range of several hours to days. The use of large computational models and very large number of parameters in practice leads to a dilemma. A simplification of the computational model is not possible because a realistic depiction of the crash process is necessary. The (arbitrary) reduction of the number of parameters leads to a poor utilization of the actually existing optimization potential in the vehicle development. The resolution of this dilemma is possible by reducing the number of possible design parameters to significant parameters, i.e. the parameters which significantly affect the design goals. The identification of these significant parameters is not trivial and can only be possible by using methods of sensitivity analysis. Existing methods and algorithms have major drawbacks as well. They are either fundamentally not adequate for complex, non-linear problems (like crash-interpretation of a vehicle) or their use implies a non-viable computational effort. The objective of this project is to research and develop methods for global sensitivity analysis of non-linear models in the simulation and preparatory studies for subsequent implementation of an innovative software prototype.
Partners:	DYNAmore GmbH Dresden – **Coordinator** TU Dresden – Institut für Bauinformatik, Faculty's Computing Centre (IT Lab)

Title:	**Campus-Navigator – The guidance system of the TU Dresden**
Project Leader:	Dr.-Ing. habil. 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 web site. All relevant information stored in the 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 the stored data by transforming them into vector graphics in the SVG format, which finally can be displayed in web 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, specifically 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 the necessary semantics. The benefits of the system include 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.

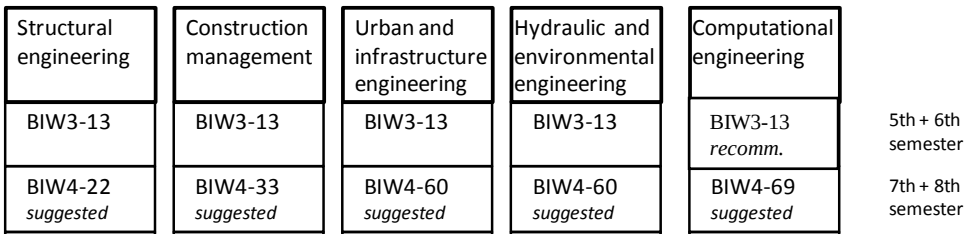
Lecture Activities

Since 2006 the students can choose construction informatics as a competence subject in their curriculum. This means that in the 4-semester Diploma course (equivalent Master Courses), starting with two preparatory lectures two semesters before, students can choose 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 4 semesters include a project work in the 3rd semester and the Diploma thesis in the 4th semester. 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 recommended as the starting module, namely BIW3-13 "Construction Informatics – Fundamentals", whereas the other one can be chosen out off the remaining four (BIW4-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 (CI) in the civil engineering curriculum



Diploma/Master course if construction informatics competence is chosen



Module BIW1-07: Construction Informatics Fundamentals

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

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 as preparatoring module and introduction module to Building Information Modelling (BIM) and is configured as an e-learning module with object-oriented e-learning tools.

Module BIW2-09: Information Management and Numerical Mathematics

Intended Audience:	Main courses of civil engineering (5th and 6th semester)
Duration:	2 semesters
Lectures and Tutorials:	Scherer, Reuter/ Windisch, 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 Information Modelling (BIM) 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 BIW2-15: System- and Information Modelling

Intended Audience:	Main courses of civil engineering (6th semester)
Duration:	1 semester
Lectures and Tutorials:	Scherer/Windisch

Subjects: The module introduces into system modelling holistic views and BIM with focus on the information flow and information logistics. Basic modelling languages like IDEF0 and EXPRESS are shown. The focus is put on the modelling of sub-systems, on aggregation and on complex relationships of the sub-systems. The students should acquire competence to model the complex energy system of buildings on different levels of granularity as well as in separate sub-systems, and synthesize these to a total system, thereby properly describing the building and the energy system both as a whole and as their parts like the solar sub-system, the building envelop, the sensor system, the building usage or the user profiles in the frame of the overall building life-cycle.

Module BIW3-13: 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/Kadolsky

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 BIW4-22: 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 BIW4-33: Software Systems

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

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 BIW4-69: 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/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 acquire 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 BIW4-70: 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/Windisch

Subject: Through the two courses of this module the students acquire basic and advanced BIM 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: Information Systems (read in English)

Intended Audience: ACCESS Master programme, European Master programme IT in construction
Duration: 2 semesters
Lectures and Tutorials: Scherer/ Kadolsky

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.

Module BIWO-04: Software Engineering

Intended Audience:	Master programme in Advanced Computational and Civil Engineering Structural Studies
Duration:	1 semester
Lectures and Tutorials:	Scherer/Reuter

Subject: This module aims at providing students with knowledge of the basics in software engineering for computational engineering, in particular complex software system design, data structures and numerical algorithms for continuous mathematics. The module is divided into two parts. The part software systems covers system capturing and system architecture, formal representation of systems, relational and object-oriented data structures, object-oriented modelling of complex engineering systems, communication and data exchange, user interfaces, and application for integrated engineering systems for monitoring and control. The part numerical methods covers the construction and analysis of algorithms to solve continuous mathematical problems, direct methods to compute the exact solution to a problem in a finite number of steps at unlimited computer precision, iterative methods to compute approximations that converge to the exact solution, solution of linear and non-linear equations, systems of equations and eigenvalue problems, numerical integration and interpolation, and implementation of the algorithms in software applications.

Publications in 2011

[1] FASCHINGBAUER G.: Simulation-based system identification in construction-simultaneous geotechnical monitoring (in German). PhD thesis. In: Berichte des Instituts für Bauinformatik, Heft 8. ISBN 978-3-86780-205-5. Dresden, January 2011.

[2] SHARMAK, W.: Dynamic Network Planning in Construction Projects using Configurable Reference Process Models, PhD thesis, In: Berichte des Instituts für Bauinformatik, Heft 9, ISBN 978-3-86780-228-4. Dresden, Germany, Mai 2011.

[3] REUTER U., SCHIRWITZ U.: Cost-effectiveness fuzzy analysis for an efficient reduction of uncertainty. In: Structural Safety 33 (2011) 232–241. Elsevier Ltd., The Netherlands, 2011.

[4] FUCHS S., KADOLSKY M., SCHERER R. J.: Formal Description of a Generic Multi-Model, Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), 2011 20th IEEE International Workshops on; Paris, France, July 2011.

[5] BENEVOLENSKIY A., KATRANUSCHKOV P. & SCHERER R.: Ontology-based configuration of construction processes using process patterns. In: Proc. of the 2011 EG-IC Workshop, Enschede, The Netherlands, July 2011.

[6] GÖKÇE, K. U., GÖKÇE, H. U., SCHERER R. J.: Holistic System Architecture for Energy Efficient Public Spaces. In: Proc. 10th International Conference in Sustainable Energy Techonologies, Istanbul, Turkey, September 2011.

[7] GÖKÇE, K. U., GÖKÇE, H. U., SCHERER R. J.: Holistic System Architecture for Energy Efficient Building Operations. In: Proc. 10th International Conference in Sustainable Energy Technologies, Istanbul, Turkey, September 2011.

[8] TAUSCHER H., SCHERER R.J.: Area cartograms in building product model visualization. A case study on the presentation of non-spatial object properties in spatial context with anamorphic maps, In: Respecting Fragile Places (eCAADe 29), Ljubljana, Slovenia, September 2011.

[9] ZAHEDI KHAMENEH A., SCHERER R. J.: A Conceptual Search-Engine for Strong Ground Motion Database (in German), 12. D-A-CH-Tagung 2011 Erdbeben und Baudynamik Hannover, Germany, September 2011.

[10] HILBERT F.: Context sensitive access to multi-models (in German). In: Proc. 23rd European Conference Forum Bauinformatik, Cork, Irland, September 2011.

[11] FASCHINGBAUER G., HOLLMANN A., SCHERER R. J.: A concept for service-oriented integration of finite-element-software in grid and cloud computing (in German); In: Proc. 4th Workshop „Grid- und Cloud-Technologie für den Entwurf technischer Systeme - Grid4TS“, ISSN 1862-622X. pp. 14-21, Dresden, Germany, 21-22 September 2011.

[12] SCHERER R. J., SCHAPKE S.-E.: A distributed multi-model-based management information system for simulation and decision making on construction projects, In: Advanced Engineering Informatics, 25(4), October 2011.

[13] SCHAPKE S.-E., FUCHS S.: Mefisto – A multi-model-based platform for construction project management (in German). In: Proc. 2nd Mefisto Congress „MEFISTO: Management – Führung – Information – Simulation im Bauwesen“, pp. 11-41, Dresden, Germany, 13 October 2011.

[14] ISMAIL A., BENEVOLENSKIY A.: Simulation of construction execution alternatives for a high-rise building (in German). In: Proc. 2nd Mefisto Congress „MEFISTO: Management – Führung – Information – Simulation im Bauwesen“, pp. 107-122, Dresden, Germany, 13 October 2011.

[15] TAUSCHER H., VOIGT M.: Visualisation of multi-model information (in German). In: Proc. 2nd Mefisto Congress „MEFISTO: Management – Führung – Information – Simulation im Bauwesen“, pp. 193-206, Dresden, Germany, 13 October 2011.

[16] GURUZ R., KATRANUSCHKOV P., LIEBICH T.: eeBIM as basis of energy analysis in the building life cycle (in German). In: Proc. 2nd Fachkonferenz Bauinformatik – Baupraxis 2011 “Industrieforschungsprojekte in der Bau-IT”, ISBN 978-3-86780-251-2, pp. 25-36, Dresden, Germany, 14 October 2011.

[17] FASCHINGBAUER G., SCHERER, R. J.: Simulation-based system identification and hierarchical 4D-BIM for foundation engineering and tunnelling (in German); In: Proc. 2nd Fachkonferenz Bauinformatik – Baupraxis 2011 “Industrieforschungsprojekte in der Bau-IT”, ISBN 978-3-86780-251-2, pp. 71-84, Dresden, Germany, 14 October 2011.

[18] HOLLMANN A., FILUS M.: Linking of finite-element simulations with building- and measured data (in German); In: Proc. 2nd Fachkonferenz Bauinformatik – Baupraxis 2011 “Industrieforschungsprojekte in der Bau-IT”, ISBN 978-3-86780-251-2, pp. 85-92, Dresden, Germany, 14 October. 2011.

[19] WINDISCH R., BAUMGÄRTEL K., PROTOPSALTIS B., SCHERER R. J.: Design of virtual wind laboratory on the basis of BIM (in German). In: Proc. 2nd Fachkonferenz Bauinformatik – Baupraxis 2011 “Industrieforschungsprojekte in der Bau-IT”, ISBN 978-3-86780-251-2, pp. 107-122, Dresden, Germany, 14 October 2011.

[20] SHARMAK W., SCHERER R. J.: Process Risk Management using Configurable Process Models, In: Proc. PRO-VE`11, 12th IFIP Working Conference on VIRTUAL ENTERPRISES, São Paulo, Brazil, 17-19 October 2011.

[21] SCHERER R. J., GRUNEWALD J., BAUMGÄRTEL K.: A Framework Approach for eeBIM and Heterogeneous eeAnalysis Data Models. In: Proc. Joint 28th CIB W78 and 6th CIB W102 2011 International Conference, Biot – Sophia Antipolis, France, October 2011.

[22] KADOLSKY M., SREWIL Y., SCHERER R. J.: Knowledge-based on site process optimization using RFID technology. In: Proc. Joint 28th CIB W78 and 6th CIB W102 2011 International Conference, Biot – Sophia Antipolis, France, October 2011.

[23] GÖKÇE, K. U., GÖKÇE, H. U., SCHERER R. J.: IFC Based Integrated Construction Management Processes. In: Proc. Joint 28th CIB W78 and 6th CIB W102 2011 International Conference, Biot – Sophia Antipolis, France, October 2011.

[24] GÖKÇE, K. U., GÖKÇE, H. U., SCHERER R. J.: The Construction Management Phases for Software Interoperability. In: Proc. Joint 28th CIB W78 and 6th CIB W102 2011 International Conference, Biot – Sophia Antipolis, France, October 2011.

[25] GÖKÇE, K. U., GÖKÇE, H. U., KATRANUSCHKOV, P.: A Model-Driven Building Management System for Low Energy Building Operation. In: Proc. Joint 28th CIB W78 and 6th CIB W102 2011 International Conference, Biot – Sophia Antipolis, France, October 2011.

[26] KATRANUSCHKOV P., GURUZ R., LIEBICH T., BORT B.: Requirements and Gap Analysis for BIM Extension to an energy efficient bim framework. In: Proc. 2nd Workshop on eeBuildings Data Models (CIB W078 – W102), Nice, France, October 2011.

[27] BAUMGÄRTEL K., GURUZ R., KATRANUSCHKOV P., SCHERER R. J.: Use Cases, Challenges and Software Architecture of a Virtual Laboratory for Life Cycle Building Energy Management. In: Proc. eChallenges e-2011, Florence, Italy, October 2011.

[28] TAUSCHER H., VOIGT M., SCHERER R. J.: Integrating visual presentations of construction multi-models: visualization design space exploration. In: Proc. CONVR2011, International Conference on Construction Applications of Virtual Reality, Weimar, Germany, November 2011.

[29] SCHAPKE S.-E., Kadolsky M., SCHERER R. J.: Representing project information spaces based on semantic multi-model annotations. In: Proc. CONVR2011, International Conference on Construction Applications of Virtual Reality, Weimar, Germany, November 2011.

[30] GÖKÇE, K. U., GÖKÇE, H. U., SCHERER R. J.: Multi Dimensional Information Management Platform for Wireless Embedded Monitoring of Building Performance Data. In: Proc. CONVR2011, International Conference on Construction Applications of Virtual Reality, Weimar, Germany, November 2011.

[31] SCHERER R., ISMAIL A.: Process-based simulation Library for construction project planning. In: Proc. of the 2011 Winter Simulation Conference, Phoenix, USA, December 2011.

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)	Intl. Council for Research and Innovation in Building and Construction (CiB)	The Netherlands
Construction Innovation	Emerald Group Publishing	UK

Membership in Standardization Groups

DIN NA 152-06-06 A17	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
buildingSMART / IAI	Building SMART International Alliance for Interoperability, German Council (product modelling in AEC/FM)	Co-ordinator of the academic group in Germany
IAI/ST-4	ST-4 Structural Model	Vice chairman