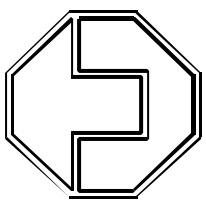
BERICHTE DES LEHRSTUHLS FÜR COMPUTERANWENDUNG IM BAUWESEN

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

INFORMATION



RESEARCH AND LECTURE ACTIVITIES

2002

December 2001

The research of the ”Institute of Applied Informatics in Civil Engineering” has – due to historical reasons – two different branches:

Applied Informatics and ***Applied Stochastics***

Applied Informatics is further sub-structured in Data Base Technologies and Artificial Intelligence. Applications are especially emphasized on virtual organisation and mobile computing in design and in the construction domain. The scope of research is not restricted to engineering problems but captures business problems as well.

The view of the brochure is directed to the future, i.e. what is planned to be done concerning new topics in 2002 based on the results achieved in 2001. Therefore topics still under research but already outlined in past information reports are not repeated here for convenience. These are: *Product Data Server for Concurrent Engineering, Legal Framework for a Virtual Enterprise, Product Data Management in a Virtual Enterprise, Dynamic Process Modelling in Concurrent Engineering, Conflict Management in a Concurrent Engineering Environment.*

The institute strongly promotes information technology in industry and research. Prof. Scherer is chairman of the European Association of Product and Process Modelling, which has been organizing its 4th conference in September 2002 at Slovenia (see *http://cib.bau.tu-dresden.de/EAPPM* or *http://2002.ECPPM.org)*. The conference will bring together the leading European academic and industrial researchers and developers in this area and the European R&D projects running in AEC at that time will present their results.

Know how transfer to the industry has indeed a high priority for the institute. The institute is very active in international and national standardization bodies in the domain of product, process, and document modelling and holds several vice-chairman positions in Germany, e.g. in product modelling DIN-NAM 96.4.3, in process modelling DIN-CALS and in document modelling DIN-DOKBAU.

e-Learning has become a very important topic. A multi-media learning project was started in summer 2001 and the institute has taken over a leading role to move to the “notebook university”, i.e. to install WLAN and provide each student with a mobile notebook. In November 2001, a project to develop a European master course in construction information technology was started, which is co-ordinated by the University of Maribor, Slovenia.

Several new EU R&D projects on concurrent engineering, mobile work, virtual organization and e-learning started in 2001

In January 2001, Dr.-Ing. Karsten Menzel came back to his roots after a 5-year successful stay at the Braunschweig university, where he was responsible for the lectures in the field of applied informatics in civil engineering. In April 2001, his PhD student Martin Keller followed him and joined the institute. In June 2001, Sven-Eric Schapke who made his Master of Science at the Georgia Technical Institute at Atlanta joined the institute and in November 2001, Karin Eisenblätter who made her master thesis on mobile work on the construction site at Carnegie Mellon supervised by Professor Garrett.

Further information may be found at our homepage *http://cib.bau.tu-dresden.de*, which will continuously be updated to provide the latest state of our research activities.

Dresden, December 2001 Raimar J. Scherer

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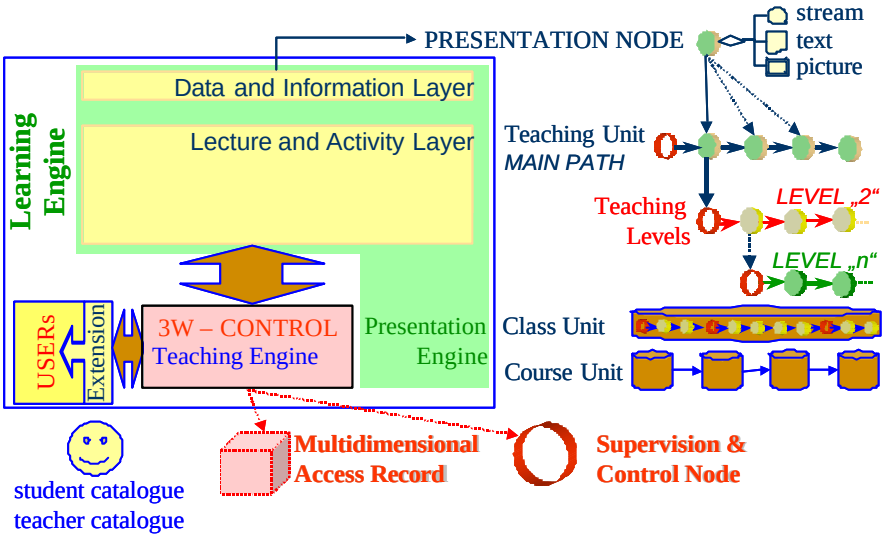
A Methodology for Information Management in e-Learning Scenarios

Karsten Menzel

Objectives

The information management scenario described in this paper is being developed for use in the PORTIKO-project a multimedia-based teaching environment for civil engineering curricula. The project consists of four parts: (A) Multimedia Based Correspondence Courses in Civil Engineering, (B) The 'Virtual Building', (C) The 'Virtual Infrastructure' and (S) the service part. The information management scenario described in this paper focuses on part (B). Within this part lecture notes, assignments, and simulations in the area of building design are developed for a project based teaching approach. This means all materials will refer to one virtual building.

Information management for such project-based teaching scenarios has to fulfill several requirements. First, it must be flexible enough to make all necessary material available to the students at the right time, the right place, and in an appropriate granularity. Second, it should support the course workflow and encourage co-operation and communication between students. Third, it requires a pretty general organization to optimize the data management efforts of the instructors. Information management should support learning and teaching instead of becoming the key issue of teaching activities.



Portiko-Project, Subproject B6: System Architecture

Approach

Basic principles of the methodology are hierarchy, patterns, and modularity that are applied to three fields: A/E/C, computer science and teaching. The figure shows a system architecture for information management that is based upon these principles.

The so-called Learning Engine consists of three parts: (A) the Presentation Engine, (B) the Teaching Engine, and (C) the User Management Engine. The presentation engine is divided into two layers, a data and information layer that simply collects and structures the "raw material" or the digitally available resources.

A Teaching Unit is also called the Main Path. It should reflect that individual learning is also possible by introducing different Teaching Levels. A Class Unit is the aggregation of all Teaching Units necessary for one class with normally 90 minutes lecture time. A Course Unit is the aggregation of all Class Units to be taught in one course.

The Teaching Engine records and controls the 'three Ws' of all learning and teaching activities which are: Who used When (for how long) What information of the system (and how successfully)? For this purpose, a Multidimensional Access Record is introduced. Additionally, a so-called Supervision and Control Node (SCN) is introduced. Each Teaching Unit contains one SCN. The SCN collects all control questions and the correct solutions from each presentation node within one Main Graph or Teaching Unit.

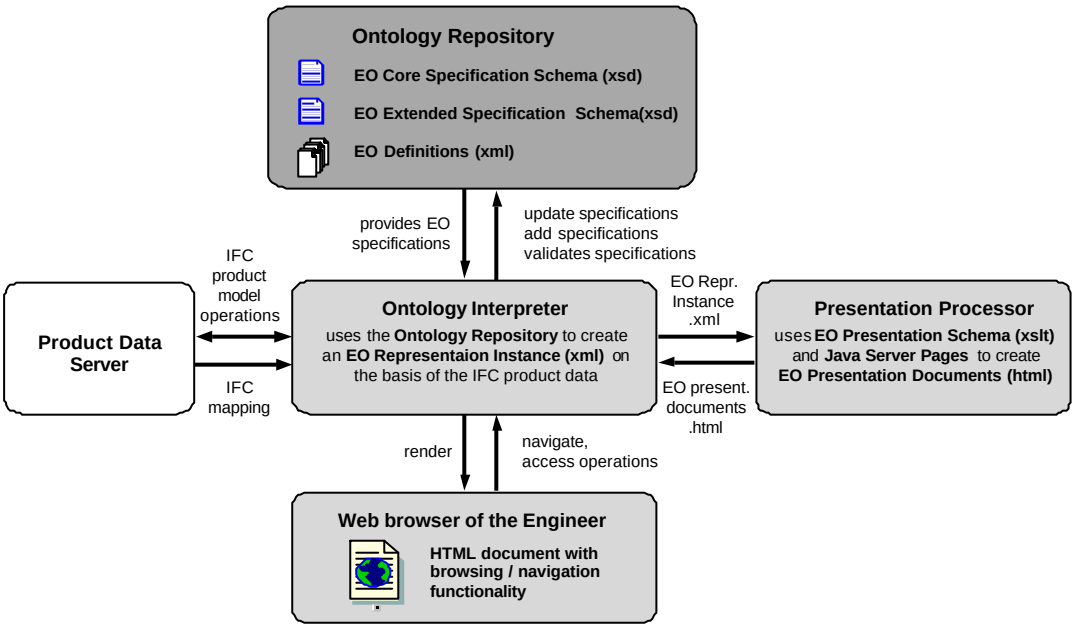
User management: The system must allow separate management of course participants and lecturers.

Web-Enabled Engineering Ontology As User Interface to Product Data

Peter Katranuschkov, Alexander Gehre

Objectives

A basic difficulty for the better acceptance of product data technology in construction practice is the lack of appropriate user-friendly interfaces to the product model data in shared project repositories. CAD systems provide a geometry based user interface but are mostly limited to simple data exchange without sufficient data base support. Other tools for product data access, such as Product Data Browsers and SDAI-based services are generally inconvenient to use as they require that the engineer is familiar with the product data structures at a very detailed level. These problems can be overcome by the development of an engineering ontology that should (1) provide a simple and light-weight basis enabling end users to access, retrieve and reason upon product data in a natural way, (2) be fully Web-enabled, based on a widely accepted technology (XML) and capable for use as an interactive exchange mechanism for structured information in a distributed environment, and (3) allow consistent forward and backward mapping between its high-level engineering semantics and the technical product data structures captured in product model schemas, such as IAI/IFC.



General architecture of the ontology services

Approach

The developed approach comprises three inter-related layers: a Core Specification Schema, a set of domain-specific ontology schemas (Extended Specification Schemas) and a set of XML-based ontology definitions, corresponding to the domain-specific schemas. The Core Schema establishes the meta structures for the definition of domain-specific ontologies. It is formally defined as a XML Schema instance and is a mandatory component of the suggested framework. The domain-specific schemas import and extend the core schema with domain concepts. Such schemas can be developed for different design and construction areas, such as structural engineering (developed as a practical example as part of this research), HVAC engineering, facilities management etc. They must also conform to the XML Schema specification, but, if the core schema is publicly available, can be freely developed by a third party without any influence of the core schema development. At last the XML-based ontology definitions provide the details of the end user semantics. In contrast to the first two layers, here the specification of concepts is accomplished by using the basic, easy to understand XML syntax, following the representation patterns provided at the first layer and extended at the second layer.

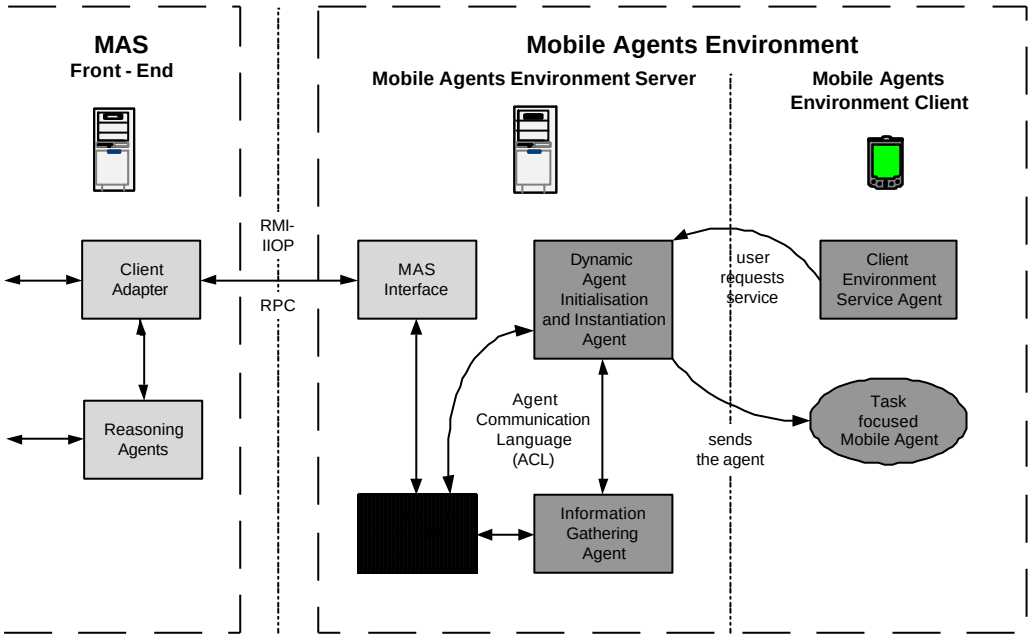
This layered approach can greatly facilitate the development of adequate ontologies by domain experts. Its implementation, outlined on the figure above, comprises an Ontology Repository, a standard Web Browser and two dedicated modules - Ontology Interpreter and Presentation Processor, as well as a product model interface, including schema-dependent mapping facilities, ensuring the interoperability with an IFC-based product data server.

Extended Agent-Based Product Model Access Services

Alexander Gehre, Peter Katranuschkov

Objectives

The actual state of development in the field of distributed engineering environments is typically based on the client/server approach and a distinct separation of application logic and project model data. Our Model Access Service (MAS), developed in a former project, also follows these principles by providing appropriate Client Adapters based on object-oriented RPCs along with a supporting user-friendly Explanation Component built over a traditional Web Browser and HTML. However, MAS currently lacks valuable product model agent functionality enabling to (1) dynamically collect the information needed to solve a specific product model task, (2) bind this information with the logic to process it, (3) add additional strategic components to the agents when needed, and (4) send the agent to the requesting client to perform the specified task within the local client environment. Such extended services can be especially useful to support thin mobile clients without permanent server connection and without abundant hardware resources by various tasks involving disconnected product model information gathering, changing and processing. The use of extended agent-based functionality can also lead to more intelligent and more effective client realisation, especially for clients on the construction site installed on PDAs and wearable computers.



Principal agents environment architecture

Approach

The agent-based extensions are built as an additional layer of the existing Model Access Services infrastructure. In place of the client programs in the original MAS environment, a server-centred mobile agents framework is being developed, that shall use all of the “static” services provided by the MAS and additionally extend them with features enabling the handling of mobile agent migration and providing a robust and modular architecture that is easy to maintain and upgrade.

As two central components of the proposed extensions, an Information Gathering Server Agent (IGA) and a generic Dynamic Agent Initialisation and Instantiation Server Agent (AIIA) shall be developed. The IGA shall use knowledge-based methods to collect the necessary information from MAS, needed to fulfil the deduced goals of the mobile agent that has to be created. Since MAS contains also a repository of internal reasoning agents, it shall be able to utilise all the sophisticated model access methods based on a dedicated Engineering Ontology built upon a standardised product model schema, such as the IFC project model. Depending on the set up specific goals of the mobile agent that needs to be created, the AIIA can then reason about the necessarry application logic that has to be bound with the information gathered by the IGA. Finally, based on the conclusions made by the AIIA, the new mobile agent will be created and initialised dynamically, and will then migrate to the client to actually perform the requested service.

Data Integration with Remote Applications – Extraction and Merging of Partial Product Models

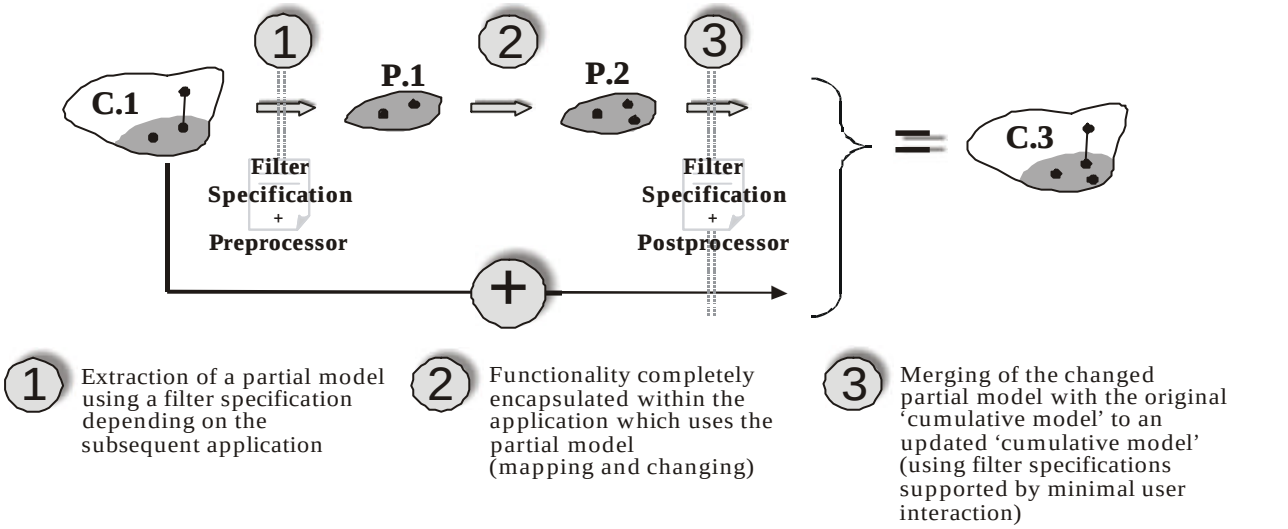
Matthias Weise, Peter Katranuschkov

Objectives

High added value for practical civil engineering work can be achieved by providing a concurrent engineering environment that can embed and support specialised client applications working most of the time 'offline' for the fulfilment of long transaction tasks. Full and efficient operability of such an environment can be accomplished if the integrated (existing or near future) applications meet the following two requirements:

- Each application can operate on its own data model and can be used offline;
- Each application supports at least one data interface dedicated to its specialized domain knowledge.

Definitely, building design professionals need different models to represent the tasks they have to solve. Data sharing and exchange is only one of these tasks, and it is the background for the interoperability of engineering applications, each acting on its own 'specialized tasks'. The latter provide the real power of each application but caused also, indirectly, the so called 'islands of automation' problem. Therefore, a solution is needed where each application maintains only its own subset of a standardized product data model so that it can concentrate on its own domain and is not forced to support the whole set of available product information. The goal of this research work is to develop an efficient methodology to define, extract and merge the required 'partial models' in order to support the data interoperability of the overall environment.



Extracting and merging of partial models

Approach

The principal problem and the proposed solution using an appropriate 'filter specification' are illustrated on the figure above. Filtering is applied to steps 1 and 3. Such formal, computer interpretable 'filter specifications' must define all relevant data supported by the associated application. A generic filter pre-processor tries to generate from a 'cumulative model' C.1 a valid partial model P.1 with an appropriate, reduced set of information. In addition, a generic filter post-processor merges the resulting (processed) partial model P.2 with the original set of information and generates a new 'cumulative model' C.3 without information loss. The aim is to achieve a highly generic, self-controlled solution with as few as possible user interactions, built upon the use of accepted or emerging new practice-relevant standards, such as IAI/IFC or ISO 10303-225.

The realisation is built upon the ISO EXPRESS specification and the underlying object-oriented paradigm. For a first validation, the potential capabilities of the short-form data exchange format defined in ISO-10303-21 is combined with a 'filter specification' running on attribute level. Based on EXPRESS the proposed algorithms can easily be applied to the IFC project model, and the filter specification can be used for a refinement of pre-defined domain specific partial models, such as the architectural, structural design, structural analysis and HVAC partial models envisaged in the frames of this research project.

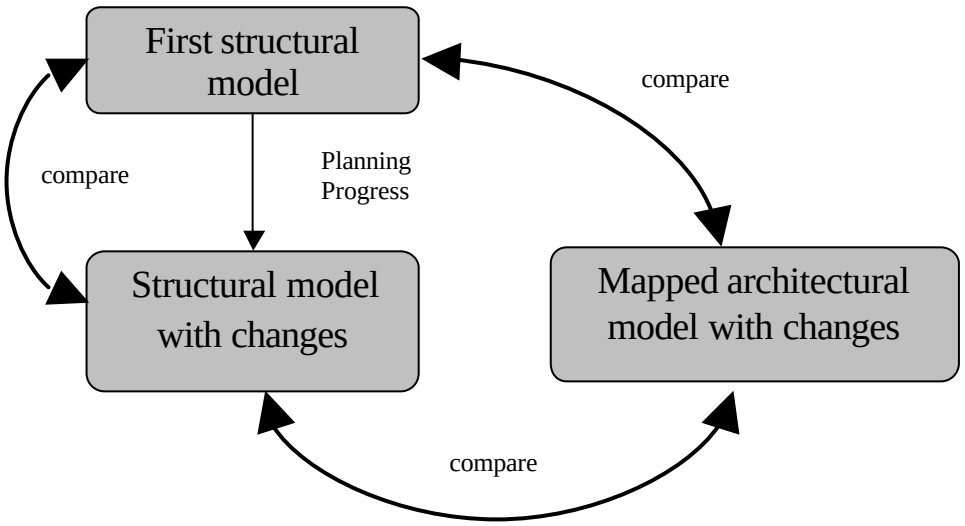
Matching of similar but different model data sets

Ulf Wagner

Objectives

Parallel planning should be increased by cooperative network planning to reduce the planning horizon and subsequently the total costs of construction. Our solution suggestion is a cooperation model, which provides starting with a common model to operate completely independently from each other for two planning participants in example a structural engineer and an architect. The datasets got only by well-defined coordination points merged. This leads to inconsistent planing states. To make them consistent again a mapping is necessary to translate the different data structure in a common structure, so that a comparison of the actual data sets is possible. The second step is to compare both data sets and mark differences in the model, which are originated by the autonomous work of the two planners.

This step is called matching. To find differences in the model data sets it is necessary to distinguish the single instances in each data set. Therefore a unique identifier is to generate, so that a fast and efficient comparison is possible. After it the models are to compare with each other, in order to identify changes which the engineers have done. Finally it is to determine if the various instances are to lead back of changes in this instance from one of the engineers or if this instance completely new respectivly the belonging instance was deleted in the other partial model.



Approach

To create an identifier for the comparison are methods like the CRC or equal hashing methods to determine. Particularly is to analyse how many bits this identifier has to involve therewith no equal identifier for different instances arise. To consider all properties beside the identifier itself this step is execute iterative, i.e. at first the identifiers are to generate for those instances, which have no references to other instances, and then are the know instances to substitute in all references in they are appear, etc. Because both planning participants making changes on their model it is necessary to state this changes before it is possible the compare the actual models, therefore the actual data set of the structural engineer is to compare with the previous model of the structural engineer to find the changes of the structural engineer. In consequence of this the three planing states (earlier structural engineer model, actual structural engineer, actual architectural model) cut compared with each other and differences cut identified.

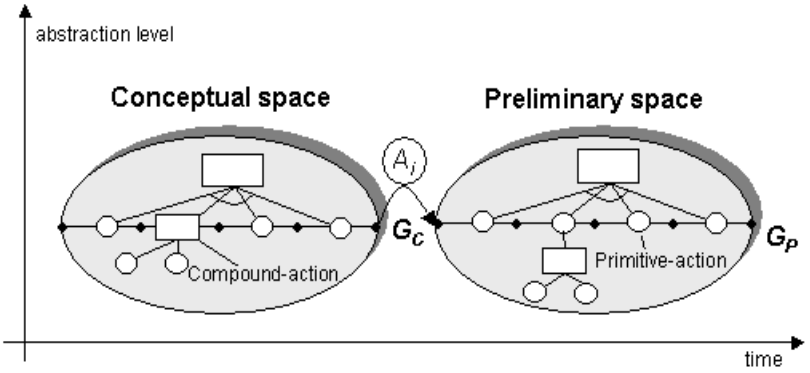
After the identification of the non identical instances it is necessary to decide, if these instances are new or if they only modified versions of existing instances. This would be possible with a knowledgebase which invokes typical properties from common instances.

Reasoning Models for Search-Control in Conceptual Structural Design

Michael Eisfeld

Objectives

The aim is to support interactively the structural engineer in finding a good conceptual design solution and to capture once created information for further use during the design process. The need for assistance particularly holds in realistic design environments, in which design processes tend to be very complex and thereby a cognitive overload for engineers can be observed due to additional tight schedules and economic considerations. We think, that a good deal of support is possible by the application of our knowledge-based design assistant system DAS being under development at CiB. In general high level of assistance requires the representation and integration of different knowledge types from practitioners by appropriate formalisms for reasoning and design process organization in such a knowledge-based system as DAS. DAS has to provide flexible assistance and control for the design process by means of different reasoning models. The models have to encode knowledge, which we have acquired by analyzing design protocols from practitioners. We found two governing knowledge types being present and exploited for control of the design process, procedural knowledge and reasoning knowledge respectively.



Composed design space showing a design sequence over distinct levels of abstraction

Approach

Our research work focuses on the representation and integration of the former knowledge types into a common computational design process given by

$$\boldsymbol{M} ? \boldsymbol{A} ? \boldsymbol{G},$$

where the set of models $\boldsymbol{M}$ is applied to find and execute a suitable set of design actions $\boldsymbol{A}$ for inferring the design goals $\boldsymbol{G}$. The computational design process has to work on the incomplete design domain theory and has to take the hierarchical and sequential nature of the design process into account, which allows reasoning by means of the models on a incomplete design state. Thereby, the applied models adapt to the available design information and thus determine the appropriate formalisms for representing the knowledge types in DAS. We have chosen the following languages for representing the control knowledge: A hierarchical task network planning language for procedural knowledge about the design process, a description and first order logic for reasoning knowledge about the structure and an algebra for reasoning knowledge about structural static members and their aggregations.

We discovered in the design protocols that engineers process a wide range of many other knowledge types. Nevertheless, we argue that at the beginning of the evolution of knowledge-based design assistants for complex design environments the realm of research has to be limited to well-understood formalisms and methods from Artificial Intelligence, that can be formally described at the knowledge level.

An Approach for a Personal Planning Service

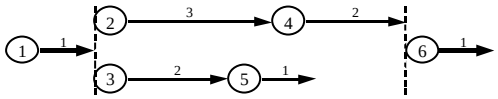
Martin Keller, Karsten Menzel

Objectives

A Personal Planning Service (PPS) shall enable users in the A/E/C domain to work more efficiently in different project contexts by supporting an enterprise-wide infrastructure allowing M:N user/project authentication, and providing individual workflows for each user. The PPS should provide a coherent solution for personalized planning of activities and work processes while supporting the engineer in getting the relevant information related to tasks and projects he concurs.

Approach

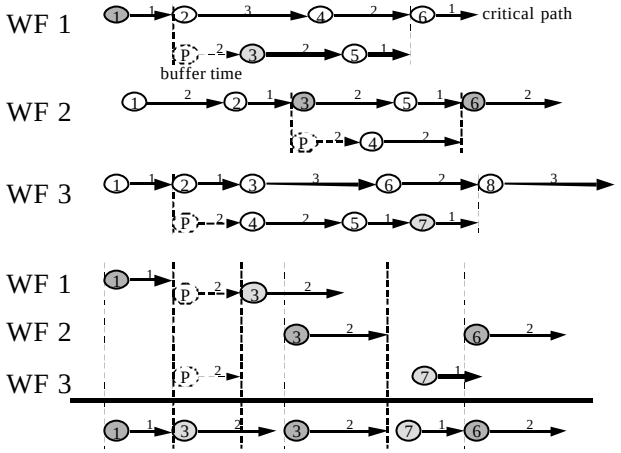
Workflows created for a single project are generally limited by the dependencies between the tasks. In order to minimize the overall project time every task will start directly after the previous task has been accomplished (critical path). To the fact that a workflow provides parallel tasks buffer time can occur (left figure).



Nach:	1	2	3	4	5	6	FZ	PZ
von: 1	0	1	1	0	0	0	0	0
von: 2	0	0	0	3	0	0	1	0
von: 3	0	0	0	0	2	0	1	2
von: 4	0	0	0	0	0	2	4	0
von: 5	0	0	0	0	0	1	3	2
von: 6	0	0	0	0	0	0	6	0
SZ	0	1	3	4	5	6		

Critical Path ⇒ 1→ 2 →4 →6
Buffer Time ⇒ 3→ 5 = 2

Calculation of Critical Path and Buffer Time



Definition of a Personal Workflow

When working in different projects the engineer may confronted with the problem that he has to perform different tasks parallel, while he only can work at one tasks at a time. On this account a personal workflow, with the restriction of no parallel tasks, has to be created. To accomplish this, the critical path as well as the buffer times are calculated for each project with methods of the graph theory. Afterwards the users tasks will be separated and merged together into a personal workflow (right figure). This automatically generated draft workflow can be optimised according to the users preferences, for instance distributing the buffer time uniformly over the workflow.

In cases that an overlapping of different tasks is inevitable by the restrictions provided by the project schedules, a delay within the project will emerge. Mechanism inside the PPS will support the user to rearrange the workflow of the project in a kind that the influences to the dependent tasks are minimized. Using software agents these information can be transmitted to other workflow-clients which can react to the modifications made the project workflow.

By integrating a Data Management System (DMS) into the PPS the workflow will not only contain information about time, status and dependency of a task, it furthermore extends the workflow by the view on the data. Thereby the user will be provided with comprehensive knowledge about the information generated within a project.

The PPS client, developed as a JAVA applet, will be started by a www-browser in which the users personal workflow is represented in a table as well as in a GANTT-Diagram. This presentation gives the engineer a comprehensive overview about the projects he is involved with and the tasks he has to accomplish. If a conflict in a project occurs the user will be informed by the PPS so that he has the opportunity to react.

Retrieval of Project Knowledge from Heterogeneous AEC Documents

Sven-Eric Schapke, Karsten Menzel

Objectives

In the building industry project corpora are the most comprehensive collections of business and engineering knowledge. We see a vital need to make these project experiences accessible to the engineer and utilize it for the corporate knowledge management. Unfortunately most project information is retained in isolated and poorly structured text documents. Furthermore the knowledge is only implicitly documented in the various project analyses and records. To guaranty for future information reuse and knowledge discovery the project information has to be flexibly structured in regard to the context in which it is needed. In this research project several methods are explored to analyse the text documents and its interdependencies. The aim is to generate semantic structures that explicitly represent a documentation's information organisation. Since these structures are in general very complex and diffuse, they have to be optimised and simplified with additional context-knowledge. By applying different context-knowledge from lexica and thesauri as well as business-, engineering- and product models the project information can than be organized to the individual needs of human beings and machines.

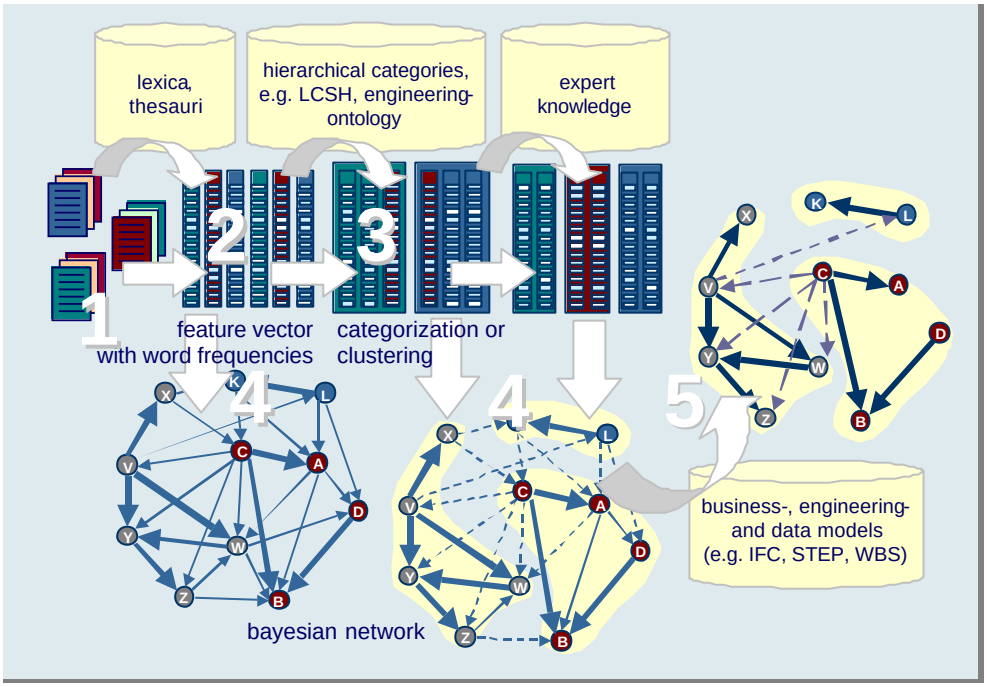


Fig. 1: Five steps to context-specifically structure project information

Approach

Our approach to structure the project information is comprised of five sequential steps (see Fig.1) : First of all the text documents are segmented and collected in a document warehouse. In a second step feature vectors are generated from the documents based on the "bag-of-word" concept. Their attributes (e.g. word-frequencies) can be weighted, considering lexica and thesauri as well as stop-words, n-grams and word-stemming. In the third step classical methods from machine learning are applied to categorize or cluster the document vectors. Here external knowledge can be applied in the form of available categorization schemes (e.g. documentation guidelines) as well as from experts using supervised methods. Nevertheless hierarchical classification schemes are not very suitable to account for the large amount of interdependencies in a typical project documentation. Hence in the fourth step the documents are structured in a bayesian network that as well represent all the minor relations among the documents and explicitly models their probabilistic dependencies. Based on this probabilistic network more sophisticated general as well as instantiated business- and engineering models can now be applied to the optimisation of the information structure.

Mobile, Wireless, Handheld Devices to Support E-Work in A/E/C

Karsten Menzel, Karin Eisenblätter

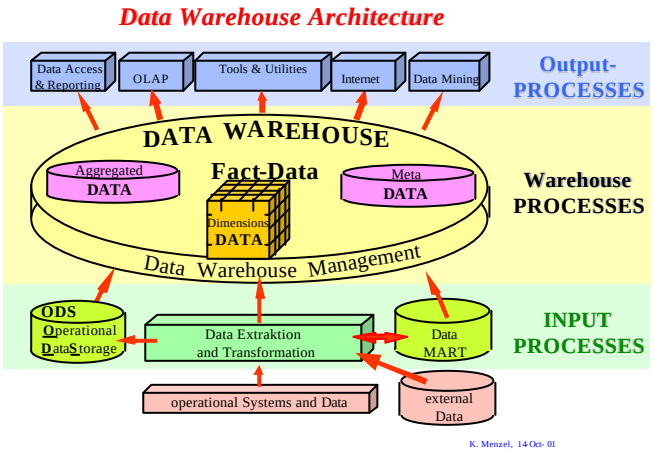
Objectives

Construction managers have to frequently acquire, modify, and access information about various construction processes, resource management, etc. in the office as well as at construction sites that are stored in different file types, e.g. as drawings, manuals or work schedules. By obtaining access to this information, for example by phone or by going back to the office, much time is lost. Furthermore, paper based information might even be forgotten or get lost.

To establish a more efficient process field personnel need support for entering and accessing information as they perform their tasks on the construction site. For this reason, construction managers should be equipped with durable and easy-to-use devices which provide a permanent connection to data sources in the back office and the internet. Using mobile devices with permanent access to databases will dramatically rationalize building processes. This research will focus on the development of an introductive strategy for wearable devices on construction sites.

Approach

The development of PDA-based and wearable computer field systems requires consideration of the following aspects: (1) Information flow analysis and business process modelling: Information will be acquired through interviews and documented in an appropriate way. Business process modelling techniques and tools allow for a structured analysis and persistent documentation. (2) Field studies and context analysis: The developed models are presented to potential users of the IT device. Thus both, the developers and the potential users, will have the necessary feedback of each other's understanding of their specific work context. (3) Design and prototyping of context-sensitive user interfaces. Since field personnel has to work in a different way than office personnel it is not sufficient to just resize a desktop-oriented software system for a laptop or a PDA. It is necessary to determine what the field personnel intends to do, or could do, with the mobile end-devices on the construction site. The project will define scope and type of data entry support, scope and type of information presentation, various types of user support such as templates, patterns, automatic location identification, etc. Data Warehouse Technology (see figure) combined with agent-technology will be used to manage and generate customized, appropriate content for on-site "delivery".



Data Warehouse Process-Layers for managing and delivering context-sensitive information

(4) Complete hard- and software design: Software architecture of such an integrated system will consist of distributed components: interface components with little computing demands running on the client and database components as well as calculation components running on the server site. If computationally intensive functionality is desired, mobile, wearable CPUs with significant computing power must be used. Additionally, a user-friendly interface for the computing device is required. Different types of displays are currently available, such as head-mounted displays or portable, flat panel displays. (5) Extended field testing: The developed system will continuously be tested in the actual field context with the various groups of potential end users such as construction managers, architects, foremen and field workers.

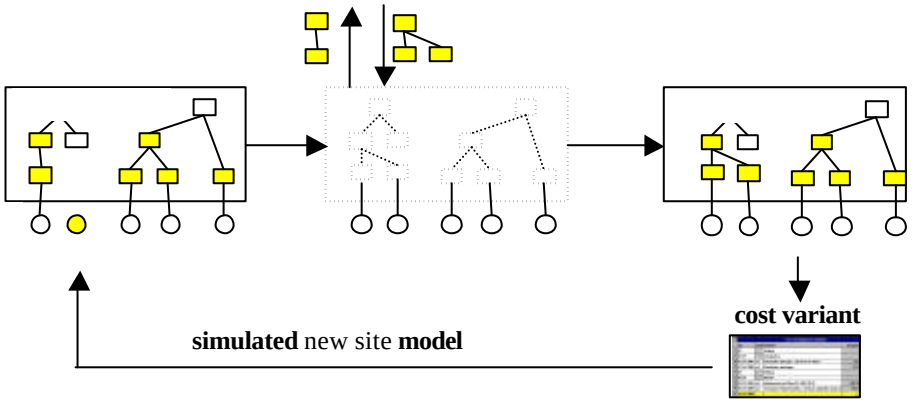
Model Based Cost-Performance Simulation of Site Facilities

Steffen Scheler

Objectives

Principally, each construction project has two goals: (1) the completion of the project in time and with high quality, and (2) the achievement of a profitable economic result. These goals are relevant for the site facilities as well. However, in current practice the cost effectiveness of the site facilities is most often neglected as a separate economic factor. The result is that the factory "construction site" only rarely produces commensurable profit.

The primary objective of this research project is to capture, monitor and continuously evaluate the pure site facilities costs. The developed approach should enable high-level cost analysis and comparison of alternative solutions through appropriate variation of the site facilities parameters with the help of a software simulation tool.



Site facilities product model for cost estimation with dynamically exchangeable model parts

Approach

The cost analysis of the site facilities is performed on the basis of (1) a dynamically modifiable site facilities product model and (2) a set of knowledge-based methods for classification of the site facilities elements and time-dependent estimation of the costs.

The site facilities product model contains the classes of all possible site facilities elements together with their inter-relationships. The actually used elements for each examined alternative comprise the instances of the modelled class structure.

The site facilities elements are examined with the help of a design tool in four dimensions, i.e. by taking into account both spatial and time factors. Each considered element is thereby assigned elementary cost and time factors. However, in order to assess properly the relevant time and cost factors, the site facilities model is assembled dynamically, from a set of partial models representing different states of the separate site facilities elements, corresponding to their time of usage and the relevant technical regulations. The model structure is designed so that the dynamic modification and exchange of one or more partial models can be achieved continuously during the simulation process. Such a partial exchange of the original product model content is needed whenever a spatial or temporal change of the site facilities elements and not only of their parameters has to be considered.

These features promote the site facilities design tool into a simulation tool. It enables the fast and easy evaluation of the costs of alternative solutions depending on the scheduled construction process and the respective site facilities usage. The costs themselves are calculated by summing up the elementary costs of the actually activated object instances at each specific point of time. However, for an accurate cost calculation by the simulation of alternative solutions with the help of time-dependent exchangeable partial models it is necessary to ensure the continuous consistency of the overall product model. This is achieved by the applied dynamic classification mechanisms based on the description logic approach.

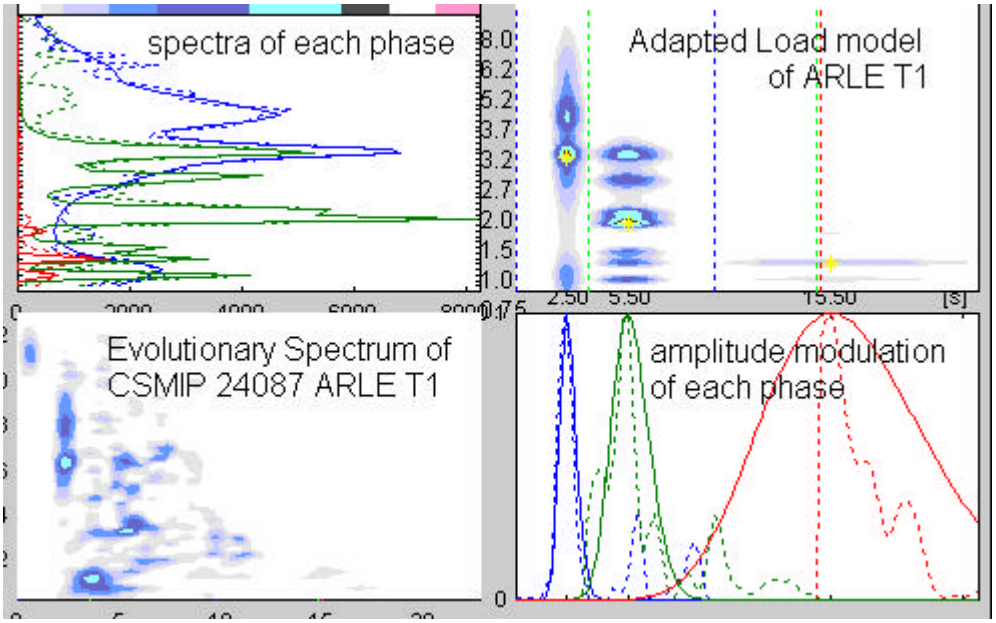
Evaluation of the proposed wave-based evolutionary earthquake load model

Jörg Bretschneider

Objectives

The quality of a predictive model for earthquake load depends strongly on thorough quantification and realistic Assessment of the (wanted as well as inherent) limitations of the model with respect to the real world. Based on the non-stationary stochastic load model of the evolutionary power spectrum (EPS) of the most energetic acceleration component along the time-dependent stochastic principal axes, a parametric model has been developed, consisting of a product approach with form functions for spectral density and amplitude modulation. It needs to be stepwise proved and optimized regarding conservation of energy and reproduction of phenomena relevant for structural load, especially resonance frequencies.

Empirical relations between parameters of the load model and topographic and seismic parameters need to be derived. The model must be enhanced with directional aspects of the ground acceleration process.



Contours of Evolutionary spectrum estimate of the Stochastic Principal Axis Component (left bottom), corresponding load model of adapted form functions (Right up) with 3 major wave phases (primary, secondary and indirect waves in blue, green, red, resp.), accompanied by plots of extracted (- - -) and adapted (—) form functions for spectra and amplitude modulation. Yellow stars are modeled peaks

Approach

The empirical load model is derived from the EPS in three steps. 1. Extraction of frequency content and amplitude modulation in the form of spectral densities and envelopes. 2. Adaptation of suitable form functions to these data. 3. Derivation of empirical relations to seismic parameters, which would enable the use of the model for prediction of load at comparable sites. The direct comparison of the extracted (1.) and adapted (2.) with the original load model by means of shape and total energy (integral) will be supplied with investigation of time series, simulated and original as well, by accepted methods of earthquake engineering practice, as are power and response spectra.

Derivation of empirical relations (3.) will be focused on the form function for frequency content, a multi Kanai-Tajimi spectrum, whose parameters are related to resonance frequencies, especially, but also magnitude and distance, all of which are essential for load prediction. Regression analyses will be done on a sufficiently broad statistical basis of recent strong motion records (California 1994, Japan 1995, Taiwan 2000).

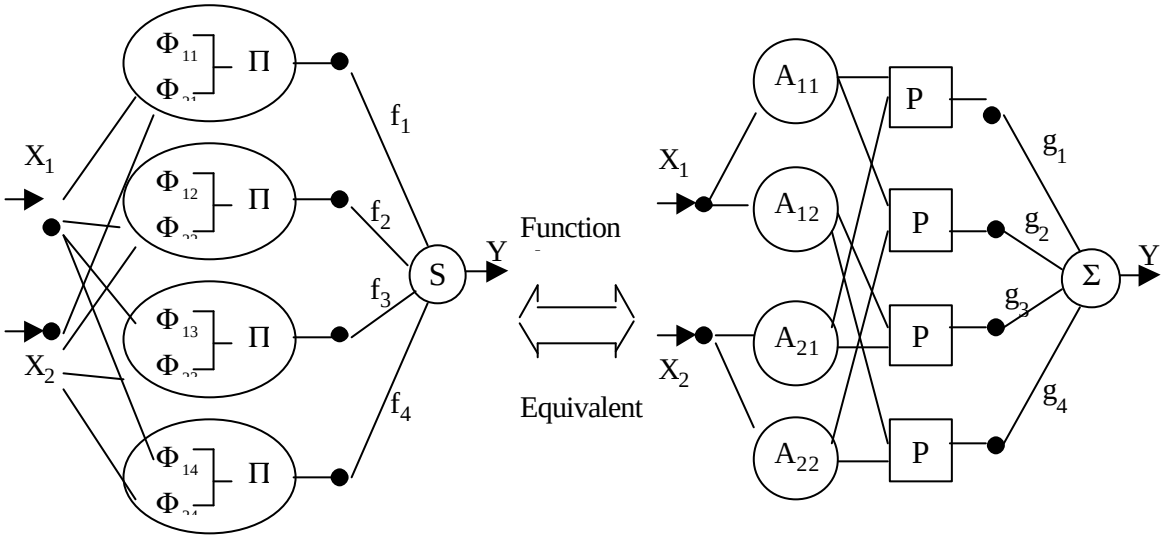
Form functions for the typical behavior of the stochastic principal axis during the dominance phases of direct (P and S), converted and guided waves (O) have to be developed.

Integration of Fuzzy Logic and Neural Networks for Active Control System of seismically excited Buildings

Shumin Qiu

Objectives

The main goal of this research is to explore the possibility of integrating fuzzy logic and neural networks and to provide an improved control schema for constructing control system of seismically exited buildings. For the topic of seismic structural control, many techniques have achieved a certain degree of success. This is a multi-input-multi-output, nonlinear control problem. However, due to the complexity and importance of the seismic structural systems, there is a need to further improve existing control techniques. The integration of fuzzy logic and neural networks gives a new research subject called neuro-fuzzy systems. These systems have the potential to capture the benefits of both fascinating fields into a single framework. The advance in technology will provide opportunities for improving existing control schemes. With the combination of artificial neural network and fuzzy logic, the seismic structural control problem can be solved using an innovative approach without the need for rigorous mathematical models.



Functional Equivalence between RBF Networks and Fuzzy System

Approach

The equivalence of fuzzy inference system and neural networks is investigated firstly from a global point view. The functional equivalence has made it possible to combine the features of these two models systemtically. Here, we limit our attention to the radial basis function networks and interpretable fuzzy system. Since the fuzzy set theory and neural networks are both numerical model-free estimators. They can share the ability to improve the intelligence of systems working in uncertain, complicate and noisy environments. This suggests that we may combine fuzzy logic control with neural networks in constructing the control system.

Two different fuzzy neural network models have been developed in this research:

(1) Fuzzy neural network (FNN): Incorporating fuzziness into neural network frameworks. This includes assigning fuzzy labels to training samples, fuzzifying the input data and obtaining output in terms of fuzzy sets.

Adaptive networks-based fuzzy inference systems for control system (ANFIS): Fundamentally, ANFIS is about taking a fuzzy inference system (FIS) and tuning it with a backprogragation algorithm based on some collection of input and output data. This allows the fuzzy inference systems to team. With the use of MATLAB Fuzzy Logic Toolbox, the adaptive neuro-fuzzy system is implemented and evaluated.

Lecture Activities 2001

Title: Computer-Aided Design and Drafting

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

Title: Computer-Aided Solutions of Engineering Problems

Intended Audience: 2nd semester, students of civil and structural engineering
Lectures and Tutorials: Scherer / Gerk
Subjects: First, a general introduction into the fundamentals of hardware and software is given. The course is focused on the programming of numerical engineering problems. Special emphasis is given to distinguishing between the topological, geometrical and the visualization model. The practical tutorials aim at writing and testing structured programs in the programming language C++.

Title: Data structures and data bases

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

Title: Relational data structures and systems data management

Intended Audience: 5th semester, students of civil and structural engineering
Lectures and Tutorials: Scherer / Gerk
Subjects: Introduction in entity relationship modelling and relational structures. Transformation and normalization procedures. Basics of SQL and design of data management system. Examples are illustrated applying ORACLE software.

Title: Computer-Aided Engineering: Applications for Structural Engineering

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

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

Intended Audience: 8th semester civil engineering students with specialisation in structural mechanics and CAE

Lectures and Tutorials: Scherer / Katranuschkov

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

Title: Artificial Intelligence Methods and Their Application in Structural Engineering

Intended audience: 9th semester engineering students with specialisation in structural mechanics

Lectures and Tutorials: Scherer / Katranuschkov

Subject: This course of lectures aims at introducing the methods of *Artificial Intelligence* to engineers related to specific problems of their daily practice as mainly design, processing of standards and team work.

In principal the students shall gain an understanding that computer support is not restricted to numerical computation, as e.g. programs for structural analysis, but also can involve manipulation of symbols and thus produce some sort of "intelligent" behaviour. The lecture is intended to introduce AI as a technology for useful programs that might influence the way engineers do their design in the future.

Title: Computer-Supported Information Management in the Building Industry

Intended Audience: 9th semester civil engineering students with specialisation in reinforced concrete structures design and construction

Lectures and Tutorials: Scherer / Katranuschkov

Subject: The effective management of design, construction and facility management information throughout the whole life cycle of a building is a task with strategic importance for the competitiveness of the building industry.

This course discusses basic information management techniques used in current engineering practice (structuring of CAD information, data exchange paradigms, workflow management), as well as emerging new software methods and techniques. On the basis of typical co-operative engineering scenarios, advanced information management methods like Internet-based communication, product, process and document modelling and information sharing are discussed. Emphasis is given to the organisation of concurrent engineering work.

Title: Numerical Mathematics

Intended Audience: 4th semester, students of civil engineering

Lectures and Tutorials: Hauptenbuchner

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

Title: Informatics in civil engineering

Intended Audience: 6th semester, students of science of the economy

Lectures and Tutorials: Hauptenbuchner

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

Title: Informatics in architecture

Intended Audiences: 1st semester, students of architecture

Lectures and Tutorials: Hauptenbuchner

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

Research Contracts

Title: **Intelligent Services and Tools for Concurrent Engineering**

Financial Support: EU, IST-1999-11508 **ISTforCE**

Person Years: 35 (total), 6.3 (CIB, TU Dresden), Duration: 2.25 years

Approach: In this project, a user-centred services platform for concurrent engineering is being developed which a) enables multi-project participation, b) supports both local and remote (rented) services with task-oriented engineering and system knowledge, c) brings information logistics and multi-project workflow support to the end-user, d) provides services and tools for e-commerce, multi-media and e-signature, as part of a legal framework supporting legally binding work results and an audit trailer, and e) can be connected to any server and virtual enterprise environment as long as these fulfil a minimum set of specifications. The developed services platform will allow to shield the user from the current IT heterogeneity of the outside concurrent engineering world.

The project is currently in its last phase which will end with a public workshop, following an intensive verification process based on practice-oriented test-bed scenarios.

Partners: Obermeyer Planen + Beraten, Germany; FIDES DV-Partner, Germany; CSTB, France; AEC3 Ltd., UK; Geodeco s.p.a., Italy; Atlante S.L., Spain; Aplicaciones de Ingenieria y Formacion S.L., Spain; Cervenka Consulting, Czech Republic; University of Ljubljana, Slovenia.

Title: **Integriertes Client-Server-System für das virtuelle Bauteam**

(Integrated client server system for the virtual building construction enterprise)

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

Person Years: 23.3 (total), 8.2 (CIB, TU Dresden), Duration: 3 years

Approach: An object-oriented distributed client-server system for concurrent engineering is being developed, which comprises the components 1) information logistics system, extending middleware methods from the technical level to project and enterprise level, 2) project management system, 3) product model server, 4) conflict management server, and 5) a number of dedicated clients enabling user-friendly access to the system's features. The data model is based on IFC and developments are carried out in close co-operation with the IAI. Legal aspects concerning e-documents and product data, responsibility and authorization structure and corresponding procedures, e.g. for conflict management and project management, are among the special topics of the project. In the forthcoming last period of the work, the developed concepts and implemented tools will be verified and refined in continuous co-operation with end-users.

Partners: Obermeyer Planen + Beraten, München; FIDES DV-Partner, München; Acerplan Planungsgesellschaft Dresden; Thomas Liebich Consulting, München; Schmitt Stumpf Frühauf und Partner, München; Planungs- und Ingenieurbüro für Bauwesen Prof. Jäger, Radebeul; Anwaltskanzlei Dr. Handschumacher & Merbecks, Dresden.

Title: **Innovation, Co-ordination, Transfer and Deployment through Networked Co-operation in the Construction Industry**

Financial Support: EU, IST-2001-33022 **ICCI**

Person Years: 10 (total), 1.3 (CIB, TU Dresden), Duration: 2,3 years

Approach: The ICCI initiative builds a cluster upon a set of 7 European IST projects with

the overall goal to enhance the co-ordination of research and development in European projects targeting the construction sector, to promote the results of selected large research efforts and to provide concerted support for the future implementation and deployment of ICT in industrial context. Based on the results of the member projects in the cluster and on the expertise of the partner organisations, ICCI will: 1) synthesise industrial requirements and processes, 2) publish ICT state-of-the-art in the fields of technical innovations and commercial offerings, 3) synthesise information for the integration of human, organisational and technical elements to provide best practice guides, 4) assess the latest developments in the area of legal and contractual support for the use of ICT in construction, and 5) identify potential new needs, strategies, implementation plans and research directions required by the industry.

Partners: CSTB, France; University of Salford, UK; Loughborough University, UK; AEC3 Ltd., UK; Delft University of Technology, Netherlands; TNO, Netherlands; VTT, Finland; IKPIR, University of Ljubljana, Slovenia.

Title: **European Network for Product and Project Data Exchange, e-Work and e-Business in Architecture, Engineering and Construction**

Financial Support: EU, IST-2001-32035 **ProDAEC**

Person Years: 7.3 (total), 0.6 (CIB, TU Dresden), Duration: 2 years

Approach: The ProDAEC initiative aims at the creation of a thematic network in the European AEC sector to promote the use and implementation of standards for product data exchange and sharing, e-Work and e-Business. The project brings together construction companies, suppliers, designers, software vendors, R&D centres and universities. Within the set up thematic network, a number of activities will be carried out as follows: 1) dissemination of standards and best practices, such as ISO 10303-STEP, ISO 13584-PLIB and IAI-IFC, 2) collecting of industry requirements to contribute to standards evolution, 3) defining a strategy for integration and harmonisation between the existing heterogeneous AEC-related IT standards, 4) establishing standardised (EDIFACT and XML-based) data and message architectures for the adoption of e-Commerce and e-Work in the construction industry, and 5) establishing liaisons with existing working groups in AEC and other related industry sectors, such as the ship-building, process plant and furniture industries.

Partners: AIDICO, Spain; Antara Technologies S.L., Spain; UNINOVA, Portugal; VTT, Finland; CSTB, France; Université Claude Bernard Lyon I, France; Haas & Partner Ingenieurgesellsschaft mbH, Germany; AEC3 Ltd., UK; Taylor Woodrow Construction Ltd., UK; Stichting STABU, Netherlands; BIC Toscana SCPA, Italy; IKPIR, University of Ljubljana, Slovenia; Cervenka Consulting, Czech Republic.

Title: **Virtual Organisations Cluster**

Financial Support: EU, IST-2001-32031 **VOSTER**

Person Years: 9.85 (total), 0.75 (CIB, TU Dresden), Duration: 2.5 years

Approach: The VOSTER project focuses on collecting and analysing the results of several leading European research projects on Virtual Organizations (VO). These results are synthesized by the VOSTER consortium.

General scientific and technological objectives of VOSTER are: (1) consolidation of VO related concepts and their relationships, VO types, characteristics and indicators; (2) identification and recommendation of VO modelling approaches; (3) identification of relevant technologies and standards and assessment of their potential use for VOs; (4) definition of functions for VO infrastructures and suggestion of implementation strategies; (5) promotion of VO

approaches in the European industries.

The main research focus of CiB is on Virtual Organization Infrastructures (WP 4); Virtual Organization Concepts (WP1), Virtual Organization Modelling (WP2), and (5) Dissemination and Implementation (WP 5).

CiB is contributing its knowledge from the ISTforCE project, especially models and expertise in the area of personalized workflow management and software delivery on demand.

Partners: VTT (Finland), FHG-IAO (Fraunhofer Society Germany), CeTIM (Center for Technology & Innovation Management, Germany), UNINOVA (Portugal), Research Institute for Operations Management – RWTH (Germany), Loughborough University (UK), YIT Corporation Ltd. (Germany), TU Dresden (Germany), Salford University (UK), Computas AS (Sweden/Norway), Consortium for Advanced Manufacturing International (UK), University of Amsterdam (Netherland), Concurrent Engineering Consulting (Italy), Silesian University of Technology (Poland)

Title: **Multimedia Based Teaching in Civil Engineering**

Financial Support: BMBF (08NM 146B) **PORTIKO**

Person Years: 33 (total), 2.5(CIB, TU Dresden), Duration: 2.5 years

Approach: The aim of the project is the development, implementation and use of multimedia learning environments for presentational and project-based teaching of civil-engineering courses in collocated as well as distant learning arrangements. For this project the partners benefit from former research projects and several years of experiences with multimedia platforms. In the Project Part A teaching and learning modules for distant learning courses in Civil Engineering are developed. The Project Part B "The Virtual House" and Part C "The Virtual Infrastructure" focus on a project based teaching approach in civil engineering education.

CiB is involved in Part B "The Virtual House" which is already used in a basic course on "building construction". The structure is modelled with CAD and is administered in a Database Management System. The various aspects of Applied Informatics with a special focus on homogeneous, total information management are taught by CiB on the basis of this "virtual building" within "Part B6 – Computer Aided Facilities Management".

Partners: Technische Universität Braunschweig (Germany), Technische Universität Dresden (Germany)

Title: **ITC-Euromaster**

Financial Support: EU, ERASMUS

Person Years: 496,000 Euro (CIB appr. 10%) Duration: 2.0 years

Approach: This project seeks to develop a European Master Course in Construction Information Technology to complement the existing portfolio of teaching programmes and to meet the growing demand for such skills in all countries. The curriculum will be defined in such a way that courses will be offered from several universities in Europe, as face-to face as well as long distance learning courses, which will give the students a possibility not just to visit other countries, but also to tailor the programme to their own wishes and needs.

Within the project CiB is contributing it's experience gathered in the national project "Portiko". The special focus of CiB is on developing teaching contents for CSCW-methods and technologies including workflow management, product modelling and database management systems, Knowledge Management, and Computer Aided Facilities Management.

Partners: University of Salford (UK), Bauhaus-Universität Weimar (Germany),

Technische Universiteit Delft (Netherlands), Technische Universität Dresden (Germany), Univerza v Ljubljani (Slovenia), University of Civil and Environmental Engineering (Iceland), Uninova - Instituto De Desenvolvimento De Novas Tecnologias (Portugal), Universidade do Algarve (Portugal), Univerza v Mariboru, Fakulteta za gradbeništvo (Slovenia)

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

Financial Support: DFG (German research foundation), Sche223/27-1

Person Years: 2, Duration: 2 years

Approach: Concurrent parallel design inevitably leady to diverging data states. Therefore methods are needed first to recognize these differences and second to transform the various domain data models into a consistent state. In this 2-year project, the research efforts are concentrated on the recognition of design differences in two and more domain models. Existing mapping methods are examined, adapted and extended, and a declarative mapping specification language for building construction based on the principle of characteristic mapping patterns is developed and implemented. The work on the realisation of appropriate mapping and matching methods takes into account recent developments in multi-database systems as well as suggested advanced version management approaches.

Title: **Seismic Wave Propagation in stochastic homogeneous layered media**

Financial Support: DFG (German research foundation), Sche223/23-1

Person Years: 3, Duration: 3 years

Approach: Applying perturbation methods, stochastic differential and integro-differential methods, the statistical moments and the statistical distribution of a) the particle movement, b) the amplification function and c) the resonance frequencies of a horizontal layered medium with random material properties and random layer thickness is sought.

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Membership in standardization groups

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