BERICHTE DES LEHRSTUHLES FÜR COMPUTERANWENDUNG IM BAUWESEN

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

INFORMATION

RESEARCH AND LECTURE ACTIVITIES

2000

December 1999

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 mainly in the design domain but a steady migration in the construction domain has happened during the last years. The scope of research is not restricted to engineering problems only but captures business problems as well. It is focused on computational design and computational enterprises.

The view of the brochure is directed to the future, i.e. what is planned to be done concerning new topics in 2000 based on the results achieved in 1999. Therefore topics still under research but already outlined in past information reports and not repeated here for convenience. These are: *Product Data Server for Concurrent Engineering with Knowledge-based Architecture, 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, Decision Support System for Re-Adjustment of Site Operations*.

The institute strongly promotes information technology in industry and research and therefore Prof. Scherer is chairman of the European Association of Product and Process Modelling, which hold their 2nd Conference at Watford near London in October 1998, excellently organized by Dr. Robert Amor, BRE. Again the conference brought together the leading European academic and industrial researchers and developers in this area and all European R&D projects running at that time presented their results. There, Prof. Scherer was re-elected as chairman of the association and Dr. Ricardo Gonçalves was elected as co-chairman and organizer of the 3rd conference on 25 - 27 September 2000 at Lisbon (see *http://wwwcib. bau.tu-dresden.de/EAPPM* or *http://www.uninova.pt/~ecppm2000*). The rapid development in this area especially in the last and ongoing years let expect a prospering conference venue in September 2000.

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.

The advancement in information technology in recent years, like Internet computing, distributed and virtual design teams, distributed data technology, workflow methods has also a strong impact on the demands of IT knowledge for civil engineers in practice. In order to reflect these developments in the studies, it was decided to re-structure the lecture courses of the basics (1st to 3rd semester) and the advanced studies (4th to 6th semester). The change of contents will be a shift from basic numerical programming towards data structures, integration and data technology in order to teach understanding of the complex distributed and virtual worlds and their application for daily problems. As a consequence CAD is shifted from the 4th to the 5th semester, C++ programming of the 1st semester will be merged with computer graphics in the 2nd semester, data methods in C++ in the 3rd semester will exchanged with Basics in Data Technologies, Numerical Methods is shifted from the 6th

to the 4^h semester, new courses in applied Data Technology will be set up for the 5^{th} semester and CAE in the 6^{th} semester will be extended to IT in CAE. CAD is now to be taught as a graphical interactive input to the product model data base and no longer as still being computer aided drafting. Other new concepts will be applied. For instance programming will be no longer taught as learning the program semantics step by step but by learning the language as a whole - as it has been good practice already in learning natural languages –, starting with complete sentences and stories and therefore learning by recognizing the semantics and grammar through the context and by doing. A complete and complex but well structured graphical program is selected as the training scenario and learning the language will be taught by altering small bits of the program immediately visualizing the results. The new courses are re-structured step by step as needed and therefore the old course terms are still valid and described in the end of this report. This re-structuring of the lecture courses is to be finished in 2001.

The re-organization of the staff the institute underwent in 1998 is meanwhile consolidated. The ESPRIT project ToCEE was successfully finished in May 1999 with remarkable results for flexible workflow methods and variable client-server technology, both leading methods for concurrent engineering in civil and building engineering. Two new large R&D projects on concurrent engineering, a national one with 7 industrial partners and a European one under the IST programme with 9 industrial partners to be started in January resp. February 2000 were acquired.

In June 1999 Ms. Jutta Oertel left the institute to take over a software developing position in the industry. Two young civil engineers, Mr. Matthias Weise and Mr. Alexander Gehre, entered the institute in November and December 1999 to enforce the current staff. Both finished their studies with excellent master theses in product modelling and applied artificial intelligence in structural system design. Two PhD theses are to be expected to be submitted in 2000 by members of the staff.

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

Dresden, December 1998

Raimar J. Scherer

Lehrstuhl Computeranwendung im Bauwesen

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Managing Temporary Inconsistencies in Co-operative Distributed Design Work

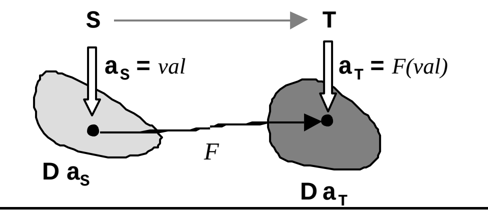
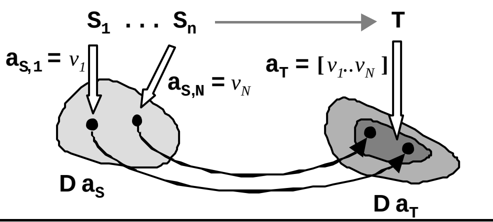
Peter Katranuschkov

Objectives

Distributed parallel design work in the virtual enterprise leads inevitably to diverging design states. Therefore it is imperative to have IT enabled methods for conflict management that can help to bring the diverging design data back to a consistent status. Methods are needed for detecting conflicting data between the partial domain models of the separate designers, for notifying the affected persons, for managing model versions, especially when conflicts are purposely deferred (leading to temporarily inconsistent data), for interactive support of the conflict negotiation process over the Internet etc.
In the current phase the research work is focused on the development of methods for ensuring the data consistency in a distributed heterogeneous modelling environment which is a prerogative for the solution of most co-operative work problems. The addressed topics differ from the usual consistency problems treated in database research because fully consistent data are required only at certain co-ordination points, whereas continuously maintained (enforced) consistency can be counter-productive.

Approach

The process of detecting conflicts between the local data of any two design team members, working with their own specific data models, can be split in two principal steps: (1) *mapping* the data contained in the model of the first designer to their appropriate representation in the model of the second designer, and (2) *matching* the resulting (mapped) data set with the already existing data of the second designer. Thus, the mapping methods take into account the structural and semantic conflicts between the schemata of the two domain models, but not the inconsistencies of the actual data, whereas the matching methods are responsible for finding the differences between two instantiated versions of one and the same model.
The matching is comprised of methods for object identification (based on a common identification schema), attribute comparison (based on known pattern matching algorithms), consistency checking and assertion (based on integrity methods used in multi-database research and on specific engineering knowledge encoded in rules) as well as interactive methods to react to detected consistency violations.

Mapping type	Schematic representation	Formal mapping specification
Functional equivalence		**(MAKE a_T FROM** **(APPLY F ARGS a_S))** i.e. the attribute a_T is determined by applying the function **F** on the source model attribute a_S as its argument.
Grouping (associative)		a) unconditional, for all **S** , **T**: **(MAKE a_T FROM ?S -> a_S)** b) conditional, only for some **S** w.r.t. a_S: **(MAKE a_T FROM** **(DESCENDANTS S FOR a_S** **WHEN *cond(S)*))**

Two examples of needed attribute level mapping patterns (S = source model, T = target model)

The mapping itself consists of analysis and classification of the applicable ”mapping patterns”, determining the sets of instances involved in each individual mapping operation by applying (iteratively) predefined conditions, generating the target model instances and, if necessary, applying post-conditions to the target model to determine the references depending on the specific data context of the target model. For the formal definition of the mapping specifications a set of *mapping patterns* on class, instance and attribute level are considered, including different cardinality and inter-model relationship types.

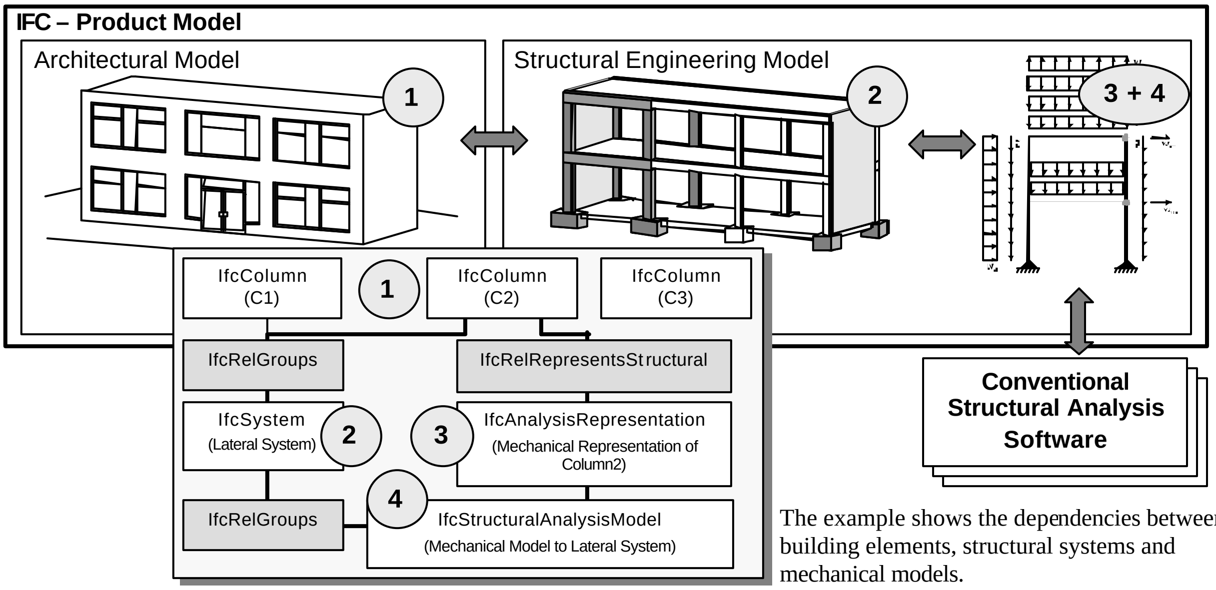
An IFC-Compliant Product Model for Building Systems

Matthias Weise, Peter Katranuschkov

Objectives

For the efficient exchange of information between all participants in a construction project the application of advanced IT methods in a common product model is needed. A promising solution to this problem is targeted by the development of the Industry Foundation Classes (IFC) promoted by the International Alliance for Interoperability (IAI). The current IFC release 2.0 supports basic parts from architecture, HVAC engineering, construction management and facilities management.

In this project an extension of the Product Model in the area of structural engineering is proposed. The goal is to represent the structural elements, mechanical assumptions and structural analysis models used in the design of a building within the frame of the given IFC object structure, so that the structural design intent can be captured and at the same time the bilateral connection with the architectural data can be preserved. What is not in scope is a detailed description of numerical mechanical models, e.g. as needed for the exchange of FE analysis data, thus limiting the model in size to the most important structural characteristics to be used for the daily structural design and co-operative work.



The example shows the dependencies between building elements, structural systems and mechanical models.

Approach

The drafted concept fulfils a pre-set requirement to use as many as possible of the existing IFC object classes and define as few as possible new "structural domain" objects. This "minimal" extension is reached in first place by utilising the possibilities of property set objects offered by the IFC model, and in second place by rearranging the structural information in such way that it fits seamlessly into predefined IFC classes or in sub-typed object structures derived from high-level IFC concepts in the line of the IFC modelling paradigm.

The specific treatment of the topological connectivity of structural elements along with the mechanical properties of the connections has been considered an important aspect in the model design. Another important aspect was to offer various capabilities for the mechanical modelling of a building's bearing structure so that the structural engineer need not follow predefined ways to describe the building structure, but can choose his own preferred way of working. To tackle this issue both spatial and planar mechanical models as well as possibilities to define substructures and to support multiple, alternative mechanical models are foreseen. The dependencies between such partial mechanical models are represented in such a way that defining and storing them is much more easier than in existing models. All available features are realised in such way that a flexible and extensible object structure is achieved.

Distributed Management of Co-operative Design Processes

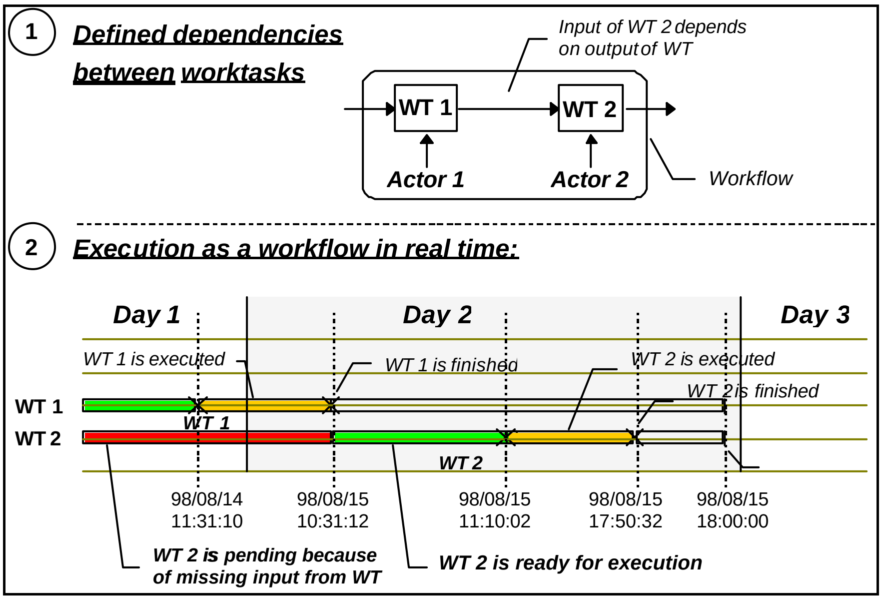
Rainer Wasserfuhr

Objectives

Main reasons for inefficient project management and project delays are the lack of information about the progress of work in a team, wrong versions or missing data before starting to work, incorrect receivers of produced data and incompatible data formats. The „islands of automation“ problem, recognized for product data management in the last decades, is now also becoming a barrier to efficient, computer-mediated project management, because different semi-integrated software solutions like document management systems, systems for messaging and email, workflow systems, project management software or PDM systems are partially overlapping in functionality. Improvements require a distributed IT system to know about the dependencies between activities of users, made transparent for users in a simple-to-use manner, with a central repository of information about users, access rights, running projects, involved organisations, available applications and document types and relate any kind of electronic communication in a project (e.g. messaging, file exchange and file sharing).

Approach

The approach of this project is a coherent framework for an integrated treatment of design document management, project management, project communication and controlling, enabled by distributed multi-user IT environments with a shared, workflow driven activity model.
The relevant participants of a design team, their activities, and organizational dependencies are modelled in a detailed object oriented model.



Simple Design Workflow: Consequences of Abstract Dependencies for the Execution in Real Time

The project and task specific maintenance of the possible roles of all participants allows to determine access rights and authorisation for changes of design data. The entire project communication and the access to any type of design documents can be done in a task centred manner. The status of tasks can be determined automatically, because time constraints and dependencies between tasks are represented and maintained by a workflow engine. A tool for ad-hoc design of workflows allows project managers to keep track of all communication flows also in large projects. Workflows are also used to describe typical patterns of interaction in teams with different responsibilities.
The implementation of the validation prototypes relies on a completely distributed object oriented model, which is formally elaborated an specified in the EXPRESS-C language, an extension of the ISO 10303 modelling language EXPRESS.

Retrieval of Project Knowledge from Heterogeneous AEC Documents

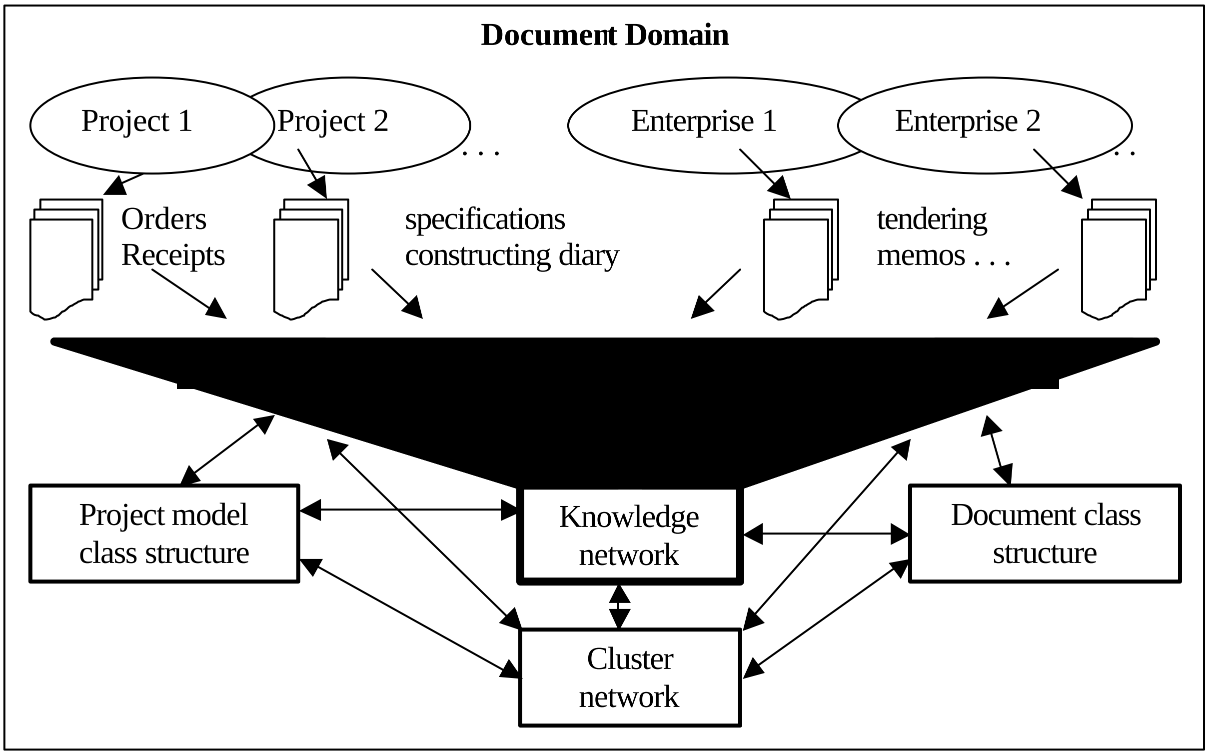
Sabine Reul

Objectives

The knowledge equation defined by A. Andersen as $K=(P+I)^S$ (K = Knowledge, P = People, + = Technology, I = Information, S = Sharing) takes effect in civil engineering in a very strong way. Information in civil-engineering documents are fragmentary because context information and interconnections between the documents are missing. The objective is to extract context knowledge from these fragmented documents. The method chosen comprises three sequential levels: On level 1 (Document Domain), a preliminary object-oriented knowledge network should be extracted from the documents by applying general text analysis methods combined with clustering techniques. In the Product Model Domain (level 2), context knowledge should be provided, which has to be extracted from the knowledge structure of the product model and product data model. On level 3 (experience Domain) uncertainty and fuzzyness will be attached in fuzzy rule networks, they combines belief networks with roles and linguistic variables.

Approach

A lexicon, which includes important parts of knowledge like construction key words, synonyms etc for the specific domain of AEC (Architecture, Engineering, Construction) will be combined with a document class structure and project class structure.



Document Domain: Extraction of context knowledge

During the process of general text analyses the lexicon will be completed with the frequency of words structured in different clusters of the building process. The knowledge network will be designed and completed by a cluster network, a project model class structure and document class structure. All parts of the knowledge network will be influenced by the other parts and have a back connection to the general text analyses with the lexicon. During the process of general text analyses different data mining concepts like fuzzy logic, neuronal networks, deductive learning, selection etc. should be investigated to find out the best fitting method for knowledge processing and description.

For instances disturbances in the building process will be analyzed and described with his influences of costs, quality of the building and time schedule. The knowledge network contains a lot of information, which can be used for the simulation of the building process, which is a further research topic of our institute.

Automated Acquisition and Improvement of Heuristic Design Knowledge

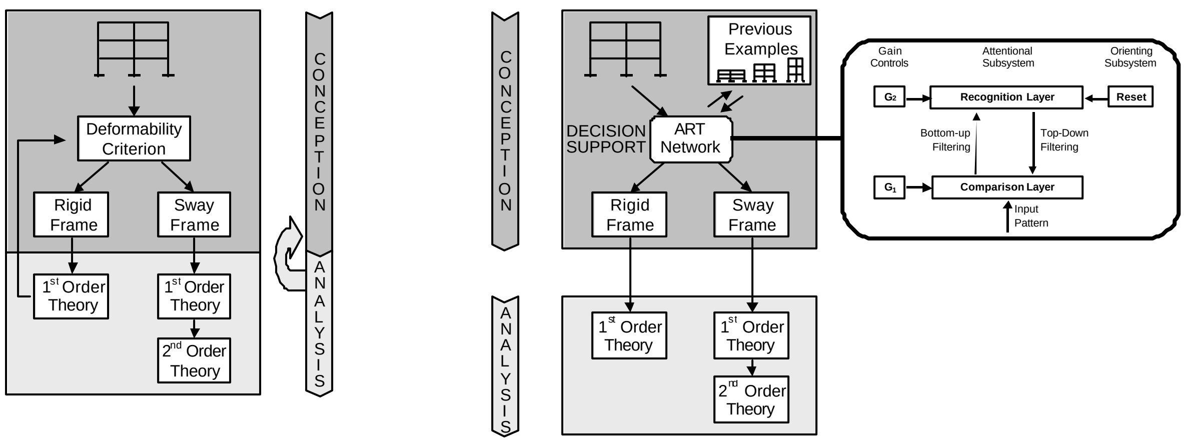
Dietmar Müller

Objectives

Generally knowledge based systems do not acquire or restructure any knowledge automatically when they are used. That means that they don't have the ability to learn. Their expert knowledge stays unchanged until it is explicitly manipulated by a human expert. Hence follows for design support systems that if several similar design projects are carried out, the effort for the designer and the quality of the computational support stay constant. The system that is focused in this work has been developed as a design assistant system for the conceptual design of load bearing structural systems resulting in a structural data model which can be analysed by conventional structural analysis tools. Cognitive aspects that have already been modelled for the design process are planning, reasoning and recognition of conflicts. The aspect of learning can be preferably applied to partial problems of conceptual and preliminary design where heuristic knowledge implicit in previous design solutions can be extracted and represented for similar design problems.

Approach

The integration of learning algorithms in a design support system with the aim to train the system by using it requires a typical ability of the human memory, not to forget old contents when learning new ones. That means for an artificial memory that new input has to be stored and accommodated to previously learned knowledge without destroying the old information. This problem that is called stability-plasticity dilemma has lead to the development of the Adaptive Resonance Theory (ART) for neural networks. ART networks belong to the general category of self-organizing or unsupervised learning systems. They attempt to model the process by which humans learn and recognize invariant properties of a given problem domain, that means they are vector or feature classifiers which are able to classify an input vector as belonging to one of the categories of stored patterns. ART networks accommodate the requirements of stability and plasticity through interactions between different subsystems, designed to process previously encountered and unfamiliar events, respectively.



Design Processes: Conventional and with an Integrated ART Network Architecture

Partial problems within the design process where ART learning algorithms can be useful are conceptual design problems where geometrical constraints of the architectural model and load conditions represent the input patterns that are to be classified in order to find an appropriate layout of the structural system very fast. An example is the design of frame systems where a categorisation into rigid and sway frames would be very helpful in the early phases of the conceptual design. The problem is that the categorisation criteria require results of the structural analysis of the completed system which is not available at this time. In practice this leads to a trial and error strategy that could be avoided by the help of a trained ART network that is able to lead the conception of a frame to the preferred category of, for example, rigid frames in order to provide a simplified stability criterion for the conceptual design phase.

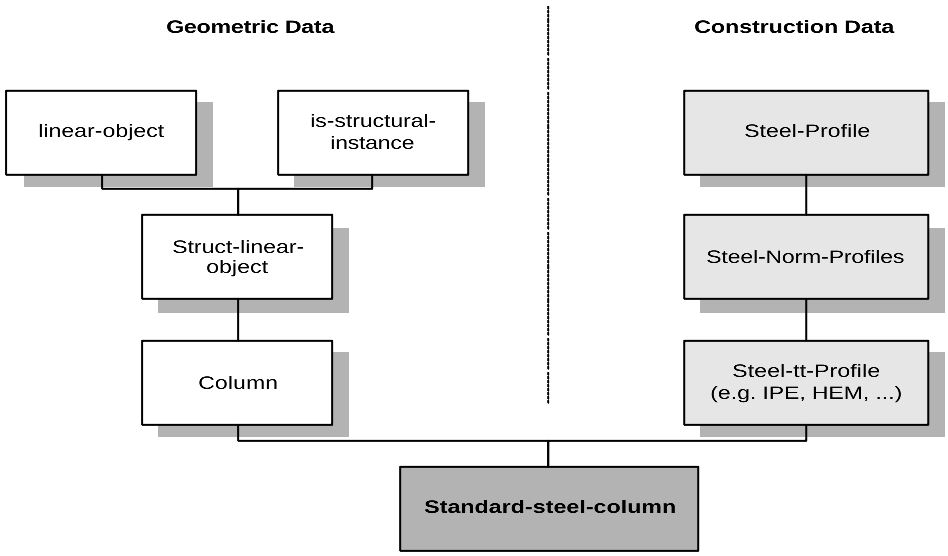
Modelling of Expert Knowledge for the Knowledge-based Design of Structural Systems

Alexander Gehre

Objectives

The design assistant PRED supports the design engineer in the earlier phases of the design process of structural systems and elements. Based on an architectural model the structural system is created within an interactive, graphic-based design process, supported through suggestions of alternative solutions from the design assistant. The design engineer has only to make decisions between possible alternatives.

PRED is a prototype indeed in the current state of development. The fundamental AI-methods were completed as far as possible, but the small amount of implemented expert knowledge is a drawback. Variability and flexibility are very important behaviours of a design tool, that has to assist the design engineer in the design of a building. In this context the great diversity of structural systems and different construction methods is a challenge the design assistant has to meet. Therefore the acquisition and representation of extensive expert knowledge is important for the further development of PRED. The representation of knowledge should be on a level that limits the interactions between the design assistant and the user to basic strategic decisions. Besides the implementation of new structural systems and parts, also the integration of new concepts, like steel construction for example, is an important goal.



Separation of geometric and construction data in the class structure

Approach

The expert knowledge, contained in codes and rules of thumb, is unsuitable for a direct use as a part of a knowledge base. Therefore appropriate ways of modelling are necessary. In the case of PRED the major goal is not the representation of exact verifications of structural parts but the development of universal algorithms for conceptual and preliminary design for early decision making.

The range of extensions for new knowledge is not limited to new formulas for dimensioning of structural members but also requires more abstract contexts like the conceptual modelling of the option to include steel structures in a design tool. At the time being it provides only expertise for reinforced concrete structures. The integration of such abstract contexts into PRED is combined with the requirement to consider highly complex interactions with other parts of the program.

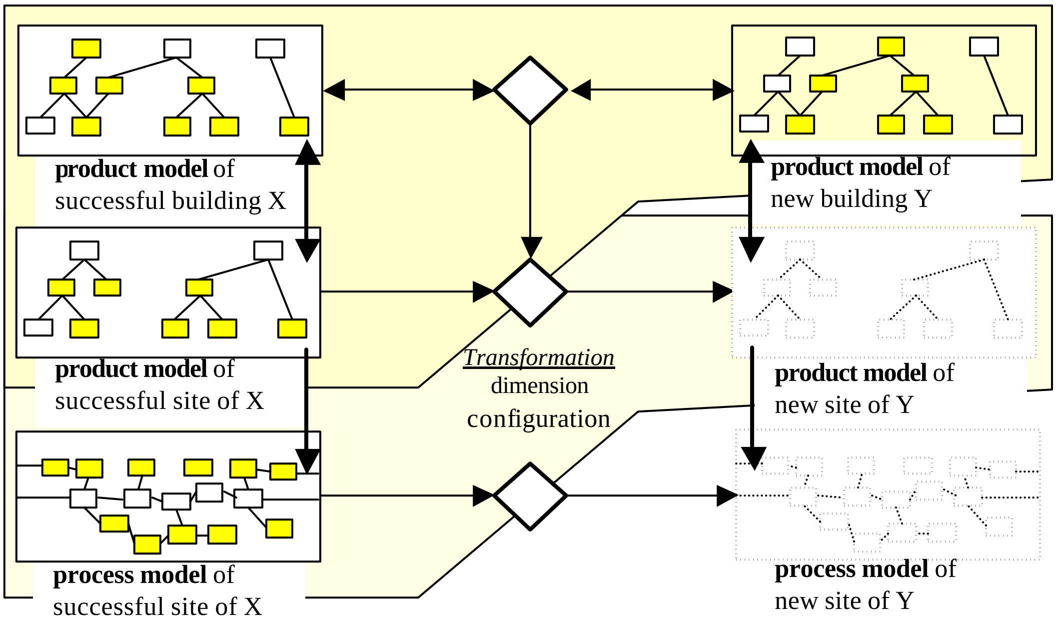
The right way to guarantee the flexibility of software for later expansions is a class structure with a late integration of the kind of construction like steel or reinforced concrete. With the concept of multiple inheritance in the class structure, it is possible to assign construction-specific information after the particularization of a structural member.

Assistant Design Tool for Configuration of the Site Facilities and the Construction Process

Steffen Scheler

Objectives

The phase of site facilities configuration is often neglected by project management during the building construction planning. Usually, a detailed planning of site facilities is done only when the construction company already started the work on the site. However, contractors are only concerned with site processes that are relevant for their own specific work not including or considering the subcontractors in sufficient preciseness. It is current practice to take the planning of an already successfully completed project as a template and to adjust it to the new constraints.
The objective is to investigate a design tool which assists in the planning and configuration of the site facilities during the construction process. The tool should make use of results and experience from successfully completed projects represented through their design product models and the partial models of the site facilities. In this way we intend to transform old successful product and process models into new models very quickly e.g. for a cost variant comparison.



Transformation from basic product model to site facilities process model as planned

Approach

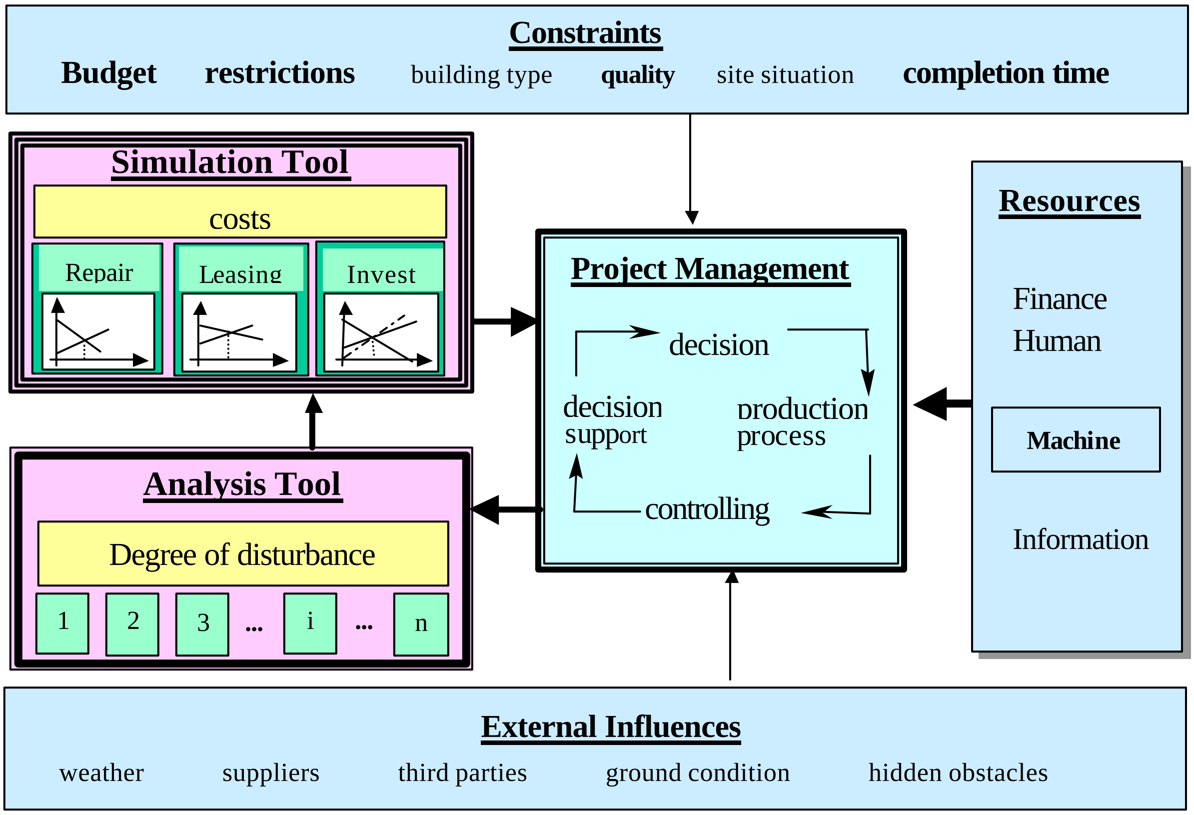
For the quick design of a new site facilities' configuration we will apply the method of case based reasoning. This is the most natural way for experts to describe knowledge through examples or cases. Such a system will inform the user about the expertise by giving examples and propose to copy them and adapt them in solving new problems if it describes situations that are similar to the new problems.
The first step of case based reasoning is to find appropriately fitting cases. This will be done by comparing the corresponding design product models. Then the available partial site facilities' model will be transformed and configured. Such an interactive determination of the actual constraints (geometric values, time units etc.) transforms the existing product model step by step into a "production model" (process model) of the targeted site facilities configuration.
A separate, implicit component of the system supports the dynamic classification process which is a prerequisite for the targeted distributed evaluation. The priority or the classification of the individual activities (objects) can change at any time during the interactive process of partial analyses. The dynamic assignment of each particular object to a given class depends hereby solely on its properties.

Object-oriented Representation of the Production Process Disturbances and Classification According to their Consequences

Ingrid Gerk

Objectives

The high complexity and the inherent risk of the production process requires continuous monitoring of the progress, especially under the influence of disturbances with complex consequences. However the registration of this observation is very difficult. The huge number and variety of disturbances with different intensity are not recognizable by using conventional methods. For most internal und external disturbances there are many possible reactions resulting in different consequences and different costs. The short decision time available does usually not allow to compare the possible reaction in detail in order to come up with the most promising one. A decision making tool would be needed which allows 1) to describe the disturbance, 2) to analyse possible reaction by simulation, 3) to easily compare different reactions, 4) gradually detail the description of the disturbance and its impact on the construction process and 5) classify the disturbance according to the risk on the construction process and the remaining risk corresponding to the reactions.



Components of the Risk Estimation and Decision Support Tool

Approach

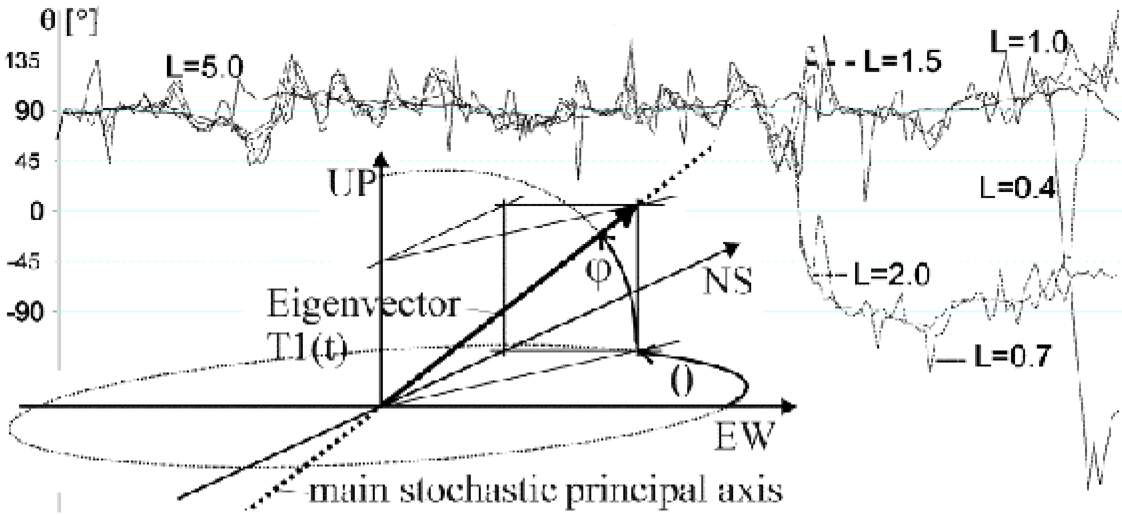
The decision support tool consists of two data bases. One for observed disturbances and corresponding reactions and one for previous cases. They infer with the product model and the production model of the construction. Further on a simulation tool, with different disturbance-dependent simulation methods with a rich graphical interactive interface and comparison techniques will be developed. The system will completely be represented in an object-oriented model, which should allow to describe and classify the disturbance in an evolutionary top-down manner. The simulation results, i.e. the investigated reactions and corresponding consequences are classified together with the disturbances and therefore they are represented in a manner to be stored in the database of previous cases and to be re-used through case-based reasoning.

Nonstationary Characteristics in Earthquake Load models

Jörg Bretschneider

Objectives

The consideration of possible earthquake loads is a substantial part of the design of buildings in earthquake prone areas. However, forecasting methods which are in common use to calculated these loads, still have failed seriously in several cases, due to strongly simplified models of the physical process of soil acceleration by earthquakes. A close-to-reality earthquake model must take into account the wave character of this phenomenon and therefore both the overlaying of different wave types and their time dependence - waves are generated and released by an impulse and weakened by absorption. Recognition of the so-called dominance phases of the different wave types in acceleration measurements and their interpretation in connection with faulting mechanisms and seismic parameters such as Magnitude, strong motion duration, etc. as well as subsurface topography between source and location is an important module in this context.



Definition of polar coordinates (angles) j and q of the stochastic principal axes and shape stability of the 2D-corrected horizontal angle q versus Window length L for a sample record of the 1994 Northridge Earthquake

Approach

Both above mentioned aspects of nonstationarity can be introduced into load models by evolutionary power spectra for individual wave types or their dominance phases, respectively, which are treated as stochastic Sub-models. The use of the method of time-dependent stochastic principal axes for the identification of those dominance phases is subject of further research. On the one hand, the shape stability of the calculated angle curves needs to be proved concerning the time window technique, on the other hand, by variable window length as well as a 3D-based correction, further improved reflection of real phenomena in the curves is to be achieved.

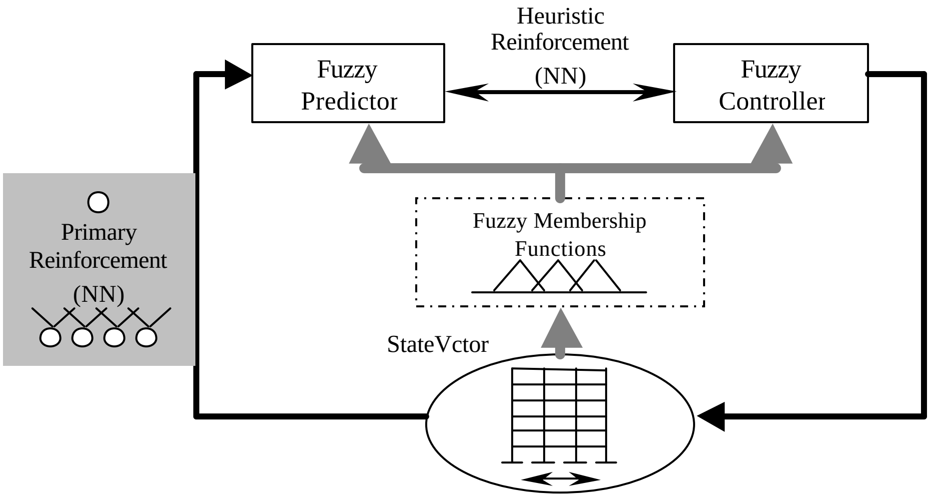
After determining the dominance phases of certain wave types in the recorded strong motion accelerograms, parameterized shape functions for evolutionary power spectra can be adapted separately for each wave type, which are then composed to a stochastic nonstationary load model. Then, empirical relations between parameters of the shape functions and seismic parameters can be derived, accomplishing a nonstationary stochastic model for the prediction of earthquake loads. Furthermore, recorded acceleration data transformed into stochastic principal axes could be used as reference components, if its frequency content can be preserved. This would substantially improve approximate modelling the 3D-acceleration process by a 1D model.

Neuro-Fuzzy Hybrid System for Control of Structural Seismic Response

Shumin Qiu

Objectives

Having investigated fuzzy logic based structural control and neural networks based structural control, a hybrid system integrating artificial neural networks and fuzzy system is further developed for controlling of seismic response of civil structure in this research. This structural control system is designed taking into account uncertainties, which are always present and cannot be neglected, especially in earthquake engineering. The integrated system will possess the advantages of both neural networks (e.g. learning abilities, optimization abilities and connectionist structures) and fuzzy systems (e.g. humanlike IF-THEN rules thinking). Neuro-Fuzzy systems as hybrid AI solution are expected to perform the fundamental requirements of intelligent controlling for seismic structures, i.e. real time nature, learning ability, handling of uncertainties and managing both symbolic and numerical information. The hybrid system as a viable problem solving approach fuses the machine learning capabilities of neural networks with transparency and representation power of fuzzy inference systems. The act combination of neural networks and fuzzy logic is to improve the real time performance, robustness and accuracy of control system of earthquake excited structure.



Neural-Fuzzy Hybrid Structural Control

Approach

The generalization and learning abilities of neural networks are utilized to realize the key components of a general fuzzy control system of seismic structure, including fuzzy membership functions, fuzzy inference rules and operators. This research focuses on the following aspects:

- As a parameter learning, the determination of member ship function can be realized by a single neuron with setting its activation function to a desired membership function. The Kohnon network and backpropagation algorithm are used for this purpose.
- For the prediction of structural seismic response, as time series, recurrent neural network is used in the control system. The numerical measurements of structural state variables can be provided to the hybrid controller by means of the combination.
- Construction of fuzzy inference rules from numerical training data: It consists of the fuzzy partitioning of the input space of controller as well as the fuzzy partitioning of the output state space of controller. The previous structural response, the earthquake ground motion, predicted structural response are selected as the input vectors of controller; the output of controller is the control force/signal.
- Neuro-fuzzy controller with reinforcement learning: To generate training data, the detailed and precise "target output", such as control force and desired seismic response, may be very expensive to obtain in controlled seismic structure. The neuro-fuzzy controller is explored with an unsupervised learning model, reinforcement learning scheme, which requires only a single scalar evaluation of the output of controller.

Lecture Activities 1999/2000

Title: Computer-Aided Solutions of Engineering Problems

Intended Audience: 1st 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. The practical tutorials aim at writing and testing structured programs in the programming language C++.

Title: Computer Graphics

Intended Audience: 2nd semester, students of civil and structural engineering
Lectures and Tutorials: Scherer / Gerk
Subjects: This lecture comprise problems of computer-aided graphical representation of two- and three-dimensional objects as well as the implementation in the programming language C++. Special emphasis is given to distinguishing between the topological, geometrical and the visualization model. Animation, technical drafting and representations by symbols are trained. The accompanying tutorials practise the implementation 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: Knowledge of elementary data structures, for instance arrays, concatenated lists, two-dimensional concatenated structures (trees, entity-relationships) and relational data structures as well as of the application of these in data bases are provided. Methods of managing memories and special algorithms for effectively storing and processing big amounts of data are taught, such as algorithms for effectively storing symmetrical and band-structured matrices as well as searching and sorting algorithms. The tutorials practise these methods and algorithms in the programming language C++.

Title: Computer-Aided Design and Drafting

Intended Audience: 4th 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), 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 Engineering: Applications for Structural Engineering

Intended Audience: 5th semester, students of structural and civil engineering
Lectures and Tutorials: Scherer / Müller
Subjects: 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. The tutorial materials are based on the practical use of the structural analysis package SOFiSTiK, but are nevertheless general enough so that a principal understanding of the application of any structural analysis program can be gained.

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: 6th 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 2000

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: A novel, user-centred services platform for concurrent engineering will be developed, which a) allows multi-project participation, b) provides servers with tasks-oriented engineering and system knowledge, c) provides information logistics and multi-project workflow support, d) provides services and tools for e-commerce, multi-media and e-signature, e) provides a legal framework to support legally binding work results and an audit trailer, f) can be connected to any server and virtual enterprise as long as these servers fulfil a minimum set of specifications. The services platform will shield the user from the current IT heterogeneity of the outside concurrent engineering world.
Partners: Obermeyer Planen+Beraten, Germany, FIDES DV-Partner , Germany, Communicacion Interactiva SL, Spain, CSTB, France, AEC3 Ltd., GB, Geodeco S.p.a., Italy, Aplicaciones de Ingenieria y Formacion S.L., Spain, Cervenka Consulting, Czech Republic, Univerity of Ljubljana IKPIR, 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 will be developed, which comprises the components 1) information logistics system, which extends middleware methods from the technical level to project and enterprise level, 2) project management system, 3) product model server, 4) conflict server. The data model is based on the 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.
Partners: Obermeyer Planen und Beraten München, FIDES DV-Partner München, Acerplan Planungsgesellschaft Dresden, Thomas Liebich Consultancy München, Wohnbau Nordwest Dresden, Schmitt Stumpf Frühauf und Partner München, Michael Schulz Anwaltskanzlei Zweibrücken

Title: Knowledge-based design support for the design of structural systems
Financial Support: DFG (German research foundation), Sche223/18-1
Person Years: 2, Duration: 2 years
Approach: The preliminary and conceptual design of the structural system done by an engineer or architect should be assisted by a design assistant system, which uses AI methods of constraint propagation and planning, where the planning operators contain rule-based knowledge. The system is structured in three design levels: the strategic level, the tactic level and the reactive level.

Title: Seismic Wave Propagation in stochastic homogeneous layered media
Financial Support: DFG (German research foundation), Sche223/23-1
Person Years: 2, Duration: 2 years
Approach: Applying pertubation methods, stochastic differential and integro-differential methods, the statistical moments and the statistical distribution of the particle movement, the amplification function and the resonance frequencies of a

layered medium is sought.

Title:	Retrieval of project knowledge from heterogeneous AEC documents
Financial Support:	DFG (German research foundation), Sche223/24-1
Person Years:	3, Duration: 2 years
Approach:	Most of the construction project knowledge is only represented in non-structured heterogeneous documents including notices and receipts, which is de facto lost, when the people leave the project. In order to make this knowledge explicit and topic-oriented, a 3-level retrieval system will be investigated. On level 1, text analysis and clustering methods will be applied directly on the documents, on level 2, the design product model will be analysed on the generic and on the instantiated level to enhance the knowledge structure, which will be represented on a believe network. On level 3, the user should be able to interact with the system and alter the believe network according to his expert knowledge. The retrieval should be represented through knowledge maps.

Scholarships

Title:	Active Control of Buildings
Financial Support:	Scholarship by the State of Saxonia, Germany
Person Years:	1, Duration: 1 years
Approach:	Application of fuzzy and neural methods to characterize the seismic load process and control the active control systems.

Publications in 1999

[1] SCHERER R. J., KATRANUSCHKOV P., Knowledge-Based Enhancements to Product Data Server Technology for Concurrent Engineering, ICE 99, Den Haag, published by the University of Nottingham, March 1999, http://www.ICE99.nl//.

[2] SCHERER R.J., GONÇALVES R.J., From Design to Business, by Way of Product Life Cycle - The EAPPM initiative, 8. Symposium on Product Data Technology, Stavanger, April 1999.

[3] SCHERER R. J., KATRANUSCHKOV P., Knowledge-Based Product Data Server for Concurrent Engineering, 8^{th} International Conference on Durability of Building Material and Components, CIB W78 Workshop on Service Life and Asset Management, IT in construction, Vancouver, published by CIB, Netherlands, June 1999.

[4] SCHERER R.J., STEURER C., Modelling and Calculation of Fatigue Crack Propagation with a Stochastic System, L. Fryba (ed.) EURODYN '99, Prague, Balkema 1999.

[5] SCHERER R.J., GONÇALVES R., Stimulating Concurrent Engineering in Construction The EAPPM Aims and Motivations, 2. International Conference on Concurrent Engineering in Construction, Helsinki, August 1999. http://cic.vtt.fi/cec99/.

[6] WASSERFUHR R., SCHERER R.J, Towards Role Based Management of Cooperative Design Processes, 2. International Conference on Concurrent Engineering in Construction, Helsinki, published by VTT, Helsinki, August 1999. http://cic.vtt.fi/cec99/.

[7] SCHERER R.J., MÜLLER D., Assistant System for the Preliminary Structural Design, 6th EG-SEA-AI Workshop in Wierzba, published by the University of Warsaw, Poland, September 1999.

[8] SCHERER R., BRETSCHNEIDER J., Identification of Earthquake Waves (in German), proceedings of the annual conference of the DGEB, published by the DGEB, Berlin, November 1999.

[9] SCHERER R., BRETSCHNEIDER J., Stochastic Identification of Earthquake Wave Entities, to be published at the 12th WCEE 2000, Auckland, New Zealand, January 2000.

[10] ZSOHAR M., SCHERER R. J., Analytical Solutions for Stochastic Seismic Waves in Random Heterogeneous and in Random Homogeneous Media based on the Smoothing Perturbation Method, submitted to the Journal Probabilistic Engineering Mechanics

Reports:

[1] WASSERFUHR R., SCHERER R. J., Process and Information Logistic Services – Documentation of the Server and Tools, Report on Task E 4 (public), April 1999.

[2] HYVÄRINEN J., KATRANUSCHKOV P., HEIMIÖ T., SCHERER R. J., Product Modelling and Interoperability - Documentation of the Server and Tools, Report F 4, April 1999.

[3] SCHERER R. J., KATRANUSCHKOV P., OERTEL J., SALONEN M., HEMIÖ T., Conflict Management - Documentation of the Server and Tools, Report H 4 (public), April 1999.

[4] SCHERER R. J. (Ed.), Migration Guidelines and Overview on the Concurrent Engineering Client-Server System, Report J 2, December 1999.

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, dep. Civil engineering	Vice chairman
DIN NAM 96.4.1-3	Product data exchange	Vice chairman
ISO 10303/Building constr	Standard Exchange of Product Data, Abt. Bauwesen	Member
ISO 10303/SGML	Standard Exchange of Product Data, dep. for linking STEP-SGML	Member
ISO 10303/CALS	Standard Exchange of Product Data, dep. CALS	Member
IAI	International Alliance of Interoperability (product modelling in civil engineering)	Member