BERICHTE DES LEHRSTUHLES FÜR COMPUTERANWENDUNG IM BAUWESEN

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

INFORMATION

RESEARCH AND LECTURE ACTIVITIES

2001

December 2000

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 2001 based on the results achieved in 2000. 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, 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 hold their 3rd Conference at Lisbon near London in September 2000, excellently organized by Ricardo Gonçalves, Uninova. 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 Prof. Ziga Turk was elected as co-chairman and organizer of the 4th conference in September 2002 at Slovenia (see *http://cib.bau.tu-dresden.de/EAPPM or http://ecppm.forAEC.com/).*

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.

Teaching re-organization is still on its way. JAVA may replace C++ as the basic programming language and tele-teaching as well as tele-engineering have strongly been discussed and will be tested in pilot studies.

Two new large R&D projects on concurrent engineering, a national one with 7 industrial partners (iCSS – Integriertes Client-Server-System) and a European one under the IST programme with 9 industrial partners (ISTforCE – Intelligent Services and Tools for Concurrent Engineering) started in January resp. February 2000.

In April 2000, Dr. Sabine Reul left the institute. Tied research is not her main favour she said but teaching is. There she has found and excellently fitting position at a kind of college. In November 2000 Rainer Wasserfuhr has left the institute without PhD in order to fully concentrate his efforts on his booming start-up company *mindbroker.de*, which was founded in 1999 and needs all his attention and effort. All of us gave him our best wishes for a continuous success. In August 2000, Michael Eisfeld entered the institute, just finished his master thesis at the KTH at Stockholm, Sweden, doing research on cognitive design. In November 2000, Ulf Wagner has joint the group, already experienced in mapping methods, due to his successful diploma thesis on that subject, which he finished at the institute.

In November 2000, Peter Katranuschkov defended his PhD thesis on interoperability methodology based on a newly developed mapping language for non-harmonized domain product models.

In January 2001, Dr.-Ing. Karsten Menzel will come 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 at an institute with focus on computational mechanics. In April 2001, his PhD student, Martin Keller, will follow him and join the institute, too, after he will have finished his current research project at the Braunschweig university.

Students are spread out throughout the world to do their master thesis abroad at colleagues' institutes to benefit from their expertise and improve co-operation links. Jan Reinhardt was at Prof. James Garrett's institute at the Carnegie Mellon Pittsburgh, USA, for finishing his master thesis about wearable computers for the construction site. Anja Wetzel was at the University of South Wales at Sydney, Australia to work with Prof. Mary-Lou Maher and finish her master thesis about Structural System Design as Co-evolutionary Design. Currently Karin Eisenblätter is doing her master thesis about site document management on mobile connected palms at Prof. Garrett's at the Carnegie Mellon.

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 2000

Raimar J. Scherer

Lehrstuhl Computeranwendung im Bauwesen

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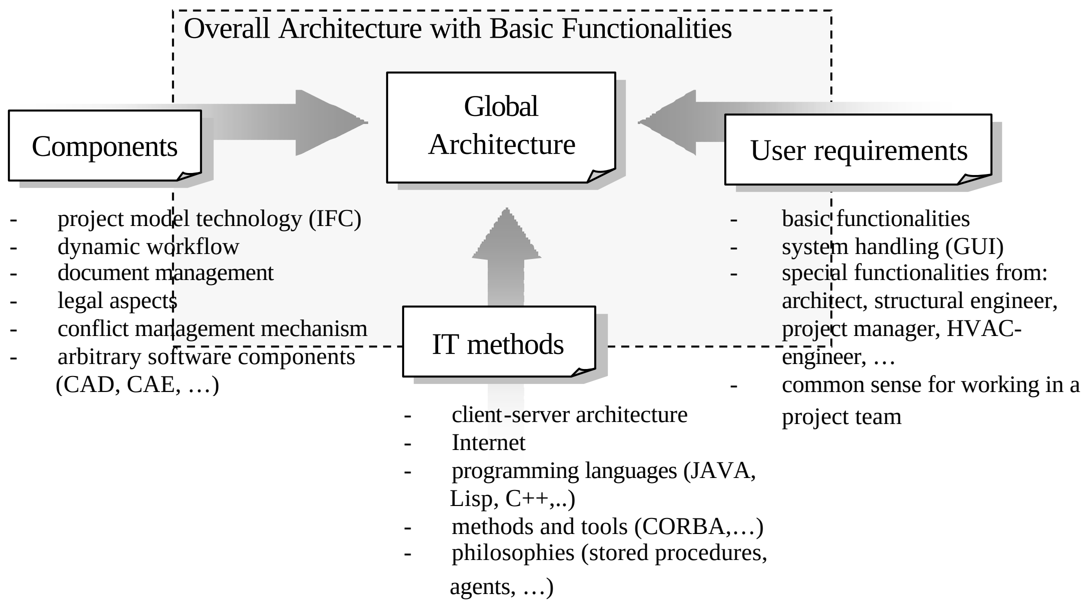
Integrated Client Server System for Collaborative Asynchronous Work

Matthias Weise, Peter Katranuschkov

Objectives

Today, the building industry exploits only a fractional amount of the existing information technology. Having in mind a computer supported concurrent engineering the asynchronous collaborative working, which is sufficient for most of routine design tasks carried out in the AEC domain, is an essential part to fulfil this vision. The goal of this research work is to deal with problems arising in the field of asynchronous collaborative working and to build up a running system showing the achievable improvements by using cognitions from other research work and finding solutions for missing parts.

Setting the focus on asynchronous collaborative working an architecture, the needed functionalities and the interfaces between the identified components are of main interest. Some of the needed components like *data management*, *workflow* and *document management* are more or less developed, but must be extended and combined with new issues like *legal aspect, conflict management mechanisms* and *workflow* extended to *dynamic workflow*. Clearing out the individual tasks of each single part and bringing them together to a stable system can lead to an easily extensible architecture. In this way, it is possible to satisfy individual needs by exchanging single components.



Approach

The project narrows down the overall goal by taking three independent ways crossing in the middle at the global architecture (see figure above). Firstly, end users are involved from the early beginning of the project and shall point out basic needs, misgivings and possible changes. Secondly, looking at known components as described above to find out their "core business" and eventual lacks. Furthermore, detecting and defining missing parts and their role in the overall system. Thirdly, investigating concepts, methods and tools provided by todays information technology to realize their possible applicability. Diminishing the scope of each widespread way shall result in an early finding of the raw global architecture. This means concentrating on basic requirements and keeps in mind the overall goal.

The IFC project model shall be used as a basis for a common understanding of the shared information, but must be extended by a structural domain model as well as legal aspects. Furthermore, a refinement of the existing workflow part is considered necessary to represent the envisaged dynamic workflow in a proper way. This may incite the IAI to enforce the development of those domains or even bring a durable upgrade of the IFC project model.

Common Data Environment for Managing Different Domain Models

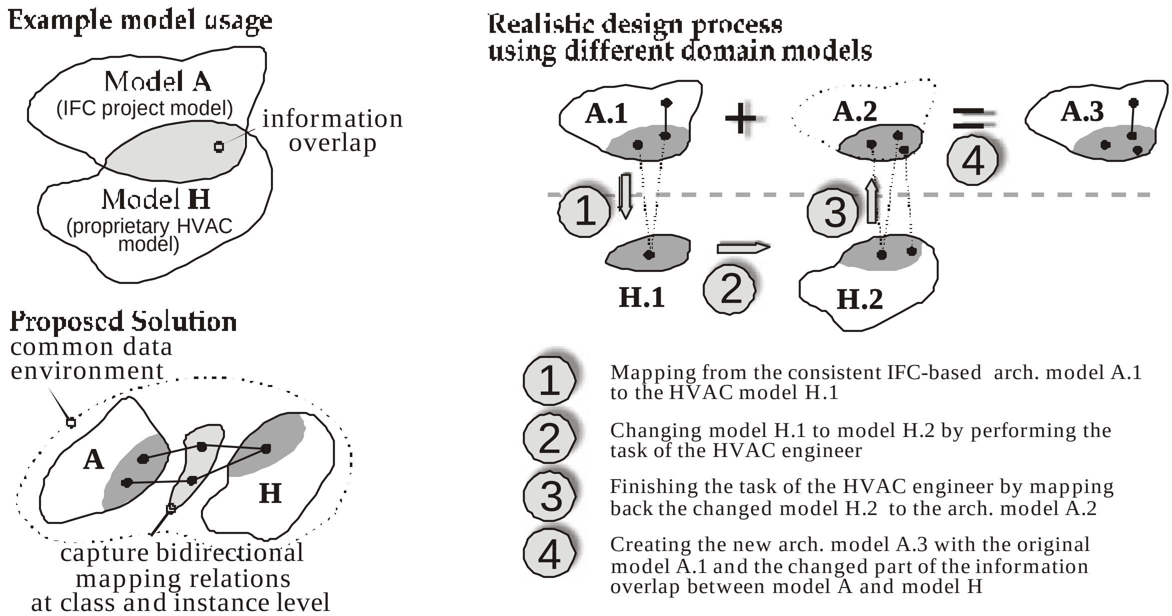
Matthias Weise, Peter Katranuschkov

Objectives

The approaches proposing the development of concurrent engineering systems on the basis of a single global model with no redundant data are commonly seen as an unrealistic vision. Therefore, the tasks related to the data transformations between different kinds of representations, generally known as *mapping*, are gaining utmost attention. However, due to the complex object-oriented models used in each specific discipline of AEC, the mapping tasks involved are very multifarious and sophisticated. In many cases, an unambiguous bi-directional transformation, as needed in the daily design process, is not definable at class level.

The symbolized design process shown on the figure below indicates that for the solution of such model transformation problems it is necessary to maintain detailed information about the mapping relations from a previous transformation (step 1) in order to perform a later transformation (step 3) in a proper way. Beyond that, the mapped data must be combined with the original version of the same model to avoid information loss.

The goal of this research work is to provide a coherent environment to integrate the used models and upon that base, to capture also the mapping specifications on class level and the mapping relations between the data instances of these models. The prototype implementation, concentrating on object-oriented models and considering new mapping technologies should provide proof for the usability of the developed concept.



Approach

Beside storing different models in a single environment, the mapping relations on class and instance level have to be captured. Therefore, classified *mapping relationships* with internal links to the used mappings are foreseen. These links shall point to external resources which either capture the full mapping specification or provide the specified mapping functionality. In the first case, a special mapping client is needed, which performs the data transformation by interacting with the data server. This case is applicable when the mapping can be done automatically, i.e. without user interaction. In the second case, the common data environment will invoke the specified mapping function(s) interactively, as needed in each particular design context. To support both cases, a server functionality enabling client-server communication and dynamic binding and invocation of external resources shall be provided.

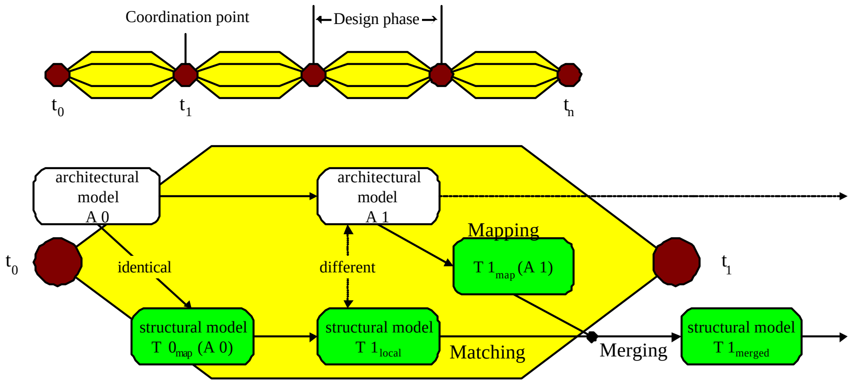
The realisation of the common data environment aims to support EXPRESS-based models, such as IFC, which renounce on some sophisticated object-oriented concepts. The environment is built upon: 1) dynamic loading and handling of several EXPRESS schemas and 2) import/export of STEP Physical Files. Furthermore, *version management methods* will be employed to tackle the different model stages in order to combine the proper data, as shown in step 4 on the figure above.

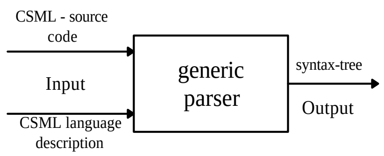
Generic Parser for an Evolving Mapping Language

Ulf Wagner, Peter Katranuschkov

Objectives

Parsing methods are basically used to prove the correctness of a formal specification, such as software code, and to disassemble it for further practical processing. In contrast to typically developed static parsers, a *generic parser* must not be tightly linked to a specific programming language, and can therefore be used for a whole set of languages using the same or a similar paradigm. In accordance with that, a generic parser for CSML can provide opportunities to modify and extend the mapping language itself, without affecting or re-programming the parser.
The mapping language CSML focused in this research is developed for the mapping processes needed in cooperative distributed design work (see figure on the left). The design work model, originally created for the cooperation of a structural engineer and an architect, is generalised in such way that, starting with a common consistent model, each designer can work on his/her own (local) model without contacting the other. These different models are *merged* at the coordination points. However, during the work process the domain models evolve in parallel, and may therefore diverge and be no longer consistent. The inconsistencies, i.e. design conflicts, have to be recognised and fixed at the coordination points.
That includes mapping, matching and merging methods which are formally specified by a common language, CSML. However, as these methods are currently under development, CSML is subject to modification and extensions as well. Therefore, a generic parser for CSML is to be preferred.





Approach

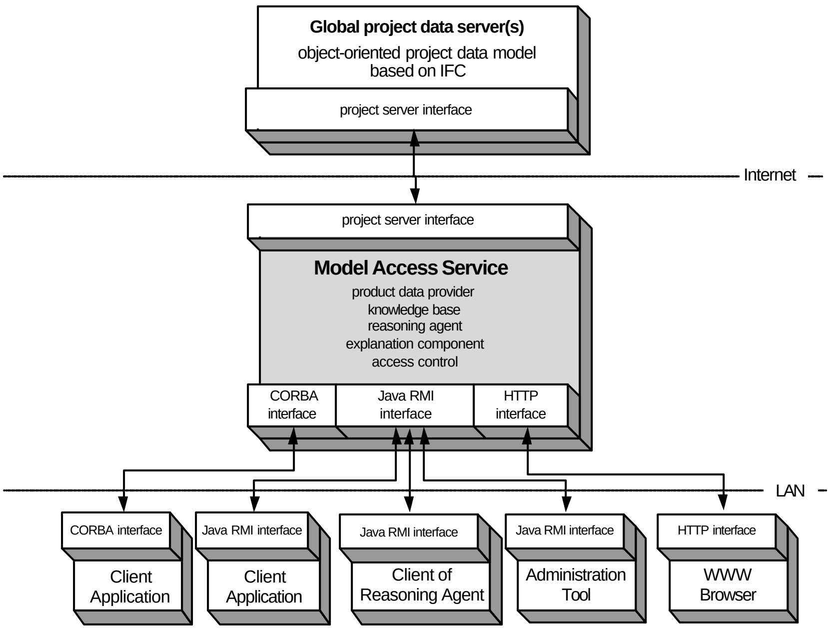
The realisation of a generic parser is more difficult than the respective implementation of a static parser because, instead of developing parsing rules for each language construct, the language itself is provided as input along with the source code to be parsed, its rules are analysed and classified at run-time, and are then dynamically applied to generically defined rule classes (see figure on the right).
The developed parser is focused on *recursively specified context-free grammars*. This category includes, but is not limited to the CSML mapping language. In accordance with the nature of the language to be parsed, a *top-down parsing method* is given preference, as opposed to bottom-up parsing used in typical programming language compilers. Top-down parsing is considered more suitable for a generic parser because it enables straight-forward generation of both the rule-tree and the parser's syntax-tree structures.
The whole process starts with the instantiation of the parser's rule classes for every grammar rule of the language, managed by a top-level class. It proceeds from top to bottom, automatically determining the interdependencies of the grammar rules in the underlying language. Each grammar rule is then progressively disassembled in its parts, until final terminating rules are reached. After that, the top-level class is used to interconnect all rules, to prove the consistency of the specific CSML code being parsed and to build the rule-tree. Finally, the rule-tree is traversed, the respective syntax-tree is deduced and the corresponding data structures to each CSML construct are set up for later use by the actual mapping method.
The generic architecture of the parser enables the encapsulation of the CSML-specific processing instructions only in the last step of the outlined procedure. In this way, further extensions of CSML can easily be tackled.

Knowledge Based Model Access Services

Alexander Gehre, Peter Katranuschkov

Objectives

In the actual development state of software providing product model data, the end-user has to understand in full detail the whole product data structure, including the particular technical semantics and the complexity of the relationships within the product data structure. Thus, an engineer, normally not familiar with product modelling, is not able to work beneficially with the product model data related to his daily work.
Therefore it is of utmost importance to make product model data and the related product data services easier to access and understand. This will be possible if the product data is complemented with additional knowledge *about* the product data. Only by the usage of such additional knowledge the engineer will be able to work on his own way and be much more effective at the end.
This additional knowledge may be provided by a *knowledge-based model access service* (MAS), acting as middleware between the engineer and the product model.



Architecture of the Model Access Service (MAS)

Approach

The targeted functionality provided by MAS cannot be achieved solely on the basis of today's commonly used object-oriented paradigm. The available object-oriented models based on STEP or IFC have to be enhanced with knowledge-based methods, but this must be done in such way that the underlying standardised object-oriented model specification remains valid to client applications. For this purpose we apply a hybrid approach unifying object-oriented programming with advanced knowledge-based representation techniques.
We are developing an *extensible modular architecture* that enhances MAS with a *Server Knowledge Base* comprised of (1) an *Engineering Ontology* specification, capturing the engineering semantics familiar to the end-users, (2) a *Reasoning Agent* for execution of sophisticated queries and appropriate automated tasks, and (3) an *Explanation Component*, responsible for "translating" the formal server responses to different user-friendly presentation forms such as HTML, VRML, table sheets etc. according to the domain-specific views of the individual end-users.
The currently developed MAS will enable the uniform access and handling of multi-project model data, that will typically remain outsourced on remote project data servers maintained by the main contractors of construction projects. MAS will be able to cache this project model data within its own knowledge base.
Because of the variety of services provided by MAS, the number and types of different service clients increases. Hence, in addition to its core functionality, MAS has to provide client interfaces based on *different communication paradigms*.

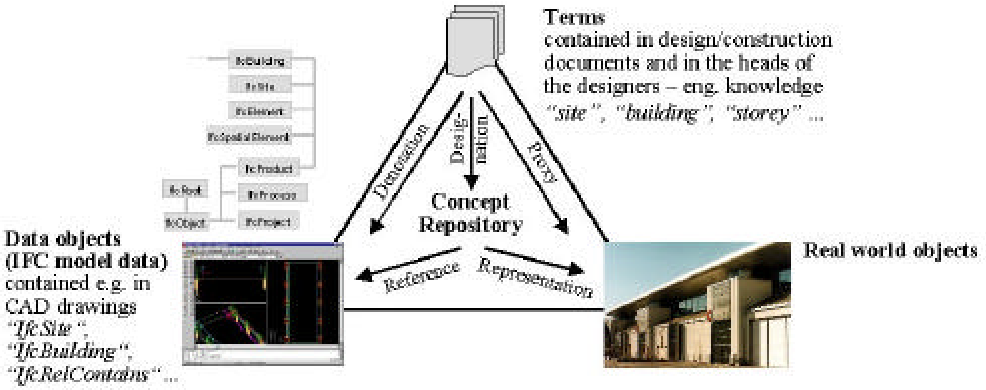
Engineering Ontology

Peter Katranuschkov, Alexander Gehre

Objectives

During the last decade, there has been considerable research in several technical domains to explore the use of formal ontologies and standardised data representations as a way of specifying content-specific agreements for the sharing and reuse of knowledge among heterogeneous software components and the respective end-users of these components. However, the achieved results are still only of limited applicability.

In this research work a more pragmatic perspective on the development of such ontologies is taken. The main target is the design and software implementation of an *engineering ontology* for the domain of civil engineering, which has the primary purpose to support end-users in their practical work with IFC-based project model data in a natural way. Such model data is strictly formalised (in order to be used in specific software applications), and therefore not readily understandable to engineers. Thus, the ontology should serve the goal to bridge the "terminological" gap between engineers and computer applications, which normally requires sophisticated graphical user interfaces, designed from scratch over and over again, as well as considerable training times for the end-users.



Basic engineering design concepts and their inter-relationship

Approach

The development of the ontology builds upon already established terminology and classification work in the civil engineering domain, as well as on the forthcoming IFC project model for (technical) product data representation. However, an ontology is more than a classification, or a hierarchy of classes, including inheritance or subsumption relations. It provides elements of both these representations, along with a well-defined set of operations, describing the *observable behaviour* of the ontology concepts. In accordance with that, the following design criteria are adopted: (1) *clarity*, i.e. the ability to effectively communicate the intended meaning of defined terms, (2) *coherence*, i.e. allowing only inferences that are consistent with the basic conceptual definitions, (3) *extendibility*, i.e. allowing the end-users to define new concepts on the basis of the existing vocabulary, and (4) *minimal ontological commitment*, i.e. keeping the ontology as small as necessary to support the intended knowledge-sharing activities between the various components of a distributed IT environment. In that last respect, the ontology design remarkably differs from product modelling which gives it greater prospects of success for application in broad problem domains.

As a whole, the ontology is comprised of the following types of data structures: (1) *meta model* and *model schemas*, representing a grouping mechanism for related concepts, and (2) *concepts*, representing the high-level entities of the specification, additionally defined by behavioural and property *features*. Typically, the structure and the semantics of the ontology concepts and the product data classes may differ, at certain places considerably. This gives rise to a variety of structural and semantic model transformation problems. In order to deal with these problems, a number of basic *mapping patterns* are defined, that can be used as building blocks for more complex and more specific mapping cases. Such patterns are e.g. "*simple equivalence*", "*set equivalence*", "*grouping*", "*homomorphic mapping*", "*transitive mapping*" etc.

The ontology can be embedded in an intelligent user-friendly model access service complementing standard product data browsers and product data servers.

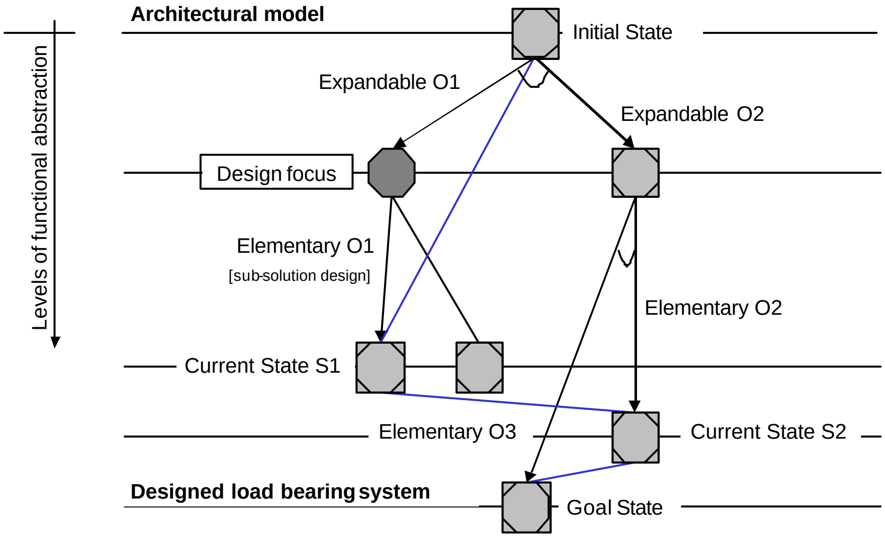
Modelling of Search-Control Knowledge for the Design Focus in Structural Conceptual Design

Michael Eisfeld

Objectives

At the current state of development the knowledge-based design assistant DAS supports interactively the structural engineer in the conceptual and preliminary phases of routine design. The assistant starts off from the highest hierarchical level of object abstraction using an architectural model given as an invariant initial problem state. It maps the conceptual design migration of the engineer on a planning board where the user can repeatedly select expandable operators from different levels of abstraction until the assistant reaches an elementary operator. The application of an elementary operator by the user changes the current problem state by triggering a tool that instantiates a design alternative prepared by the expandable operators. The interactive design process persists until all structural members have been instantiated and an overall consistent load bearing system has been generated.

However, structural engineers often investigate feasible conceptual solutions by means of a variable design focus, which is orientated by their design principles and known sub-solution designs. The development of design focus knowledge, search-control knowledge and their formalization is a challenging task. Such an extended DAS would facilitate larger flexibility for the user in the assisted design process and the ruling out of non-suitable alternatives for different structural design problems.



The problem space showing a design sequence over distinct levels of abstraction

Approach

Case studies of designing engineers build the prerequisite for disclosing the correlation of design focus and underlying search-control knowledge. They are also the very foundation of developing a structural ontology and developing procedural knowledge guiding the structural design process. The ontology of the design assistant will be represented in first order logic focusing on structural characteristics. Thereafter the procedural knowledge will have to be elicited and appropriate forms of knowledge representation for processing the structural knowledge will have to be determined. Pattern matching methods triggered by major principles will be used for the description of the design focus, which depends strongly on the symbolic languages used by the structural engineer including sketches and figures. The search-control knowledge is constituted in the design prototype by rules connecting design principles with selection of alternatives and by cases of sub-solution methods containing their functional properties and their behaviour. This results in a faster drawing up of a structural scheme by means of the knowledge base and in the evolution of feasible and working structural schemes to similar but unknown problem specifications at the initial state of the design process.

International, Collaborative Project-based Teaching in Architecture, Engineering and Construction (A/E/C) - A Methodology

Karsten Menzel[1]

Objectives

This project uses results of an international, interdisciplinary, and collaborative teaching activity between five academic institutions in the U.S., Germany and Switzerland. The project-oriented education scenario was developed inductively from the example to the general case. Project orientation supports interdisciplinary work. The students applied specific knowledge gained in isolated courses in the early phases of the curriculum to complex design scenarios. Also, they improved teamwork, communication, and presentation skills in an international scenario and learn to deal with cultural, time zone, and location differences.
For lecturers the most important benefit of using information and communication technology in teaching was/is generated by the necessary reorganization of classes, lecture notes and curricula.
The main part of the project was a common assignment that focuses on the development of a complete design for a specific building. This assignment was coupled to courses that are already part of the curriculum of the participating universities.

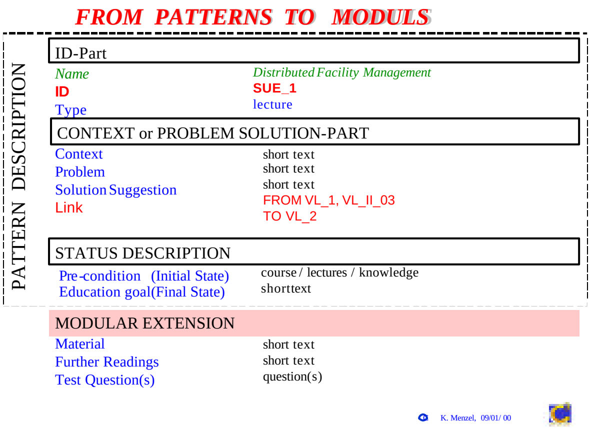


Fig. 1: Lecture Description: Using Patterns and Modular Extension

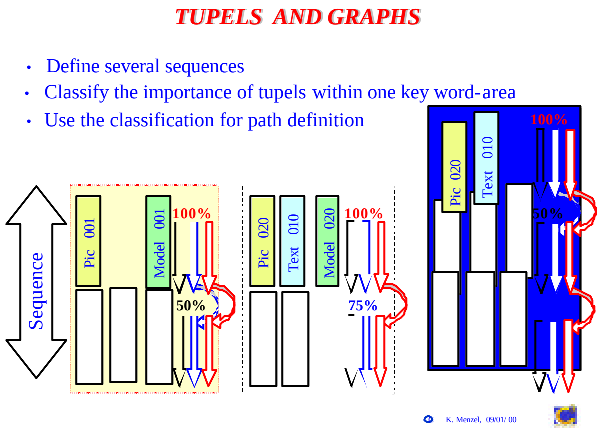


Fig. 2: Knowledge Management: Using Tupels, Graphs, and Valance Values

Approach

The goal of this project was to develop a methodology that supports knowledge management in different application scenarios: (1) during the design phase of a building, (2) for facility management, and (3) for the various educational scenarios (distant learning, customized life-long learning, etc.).
In the course of the project, extensive documents have been created that can be seen as 'knowledge containers' and which contain valuable information. This project information should be available to each succeeding person working on the project in the future. The numerous documents and their different forms (texts, models, drawings, etc.) require a well-organized structure. Documents of different types can be combined into logical units by using tupels. Additionally, users can assign a value to the tupels in order to express a valance. In this way, filter functions are available which can be used according to the qualification and information demand of specific user groups.
The basic principles of this knowledge management approach are hierarchy, patterns and modularity. These principles were applied to three fields:

(1) A/E/C - the architecture and engineering aspect,
(2) informatics - the management aspect (data, information, knowledge),
(3) teaching - the educational aspect.

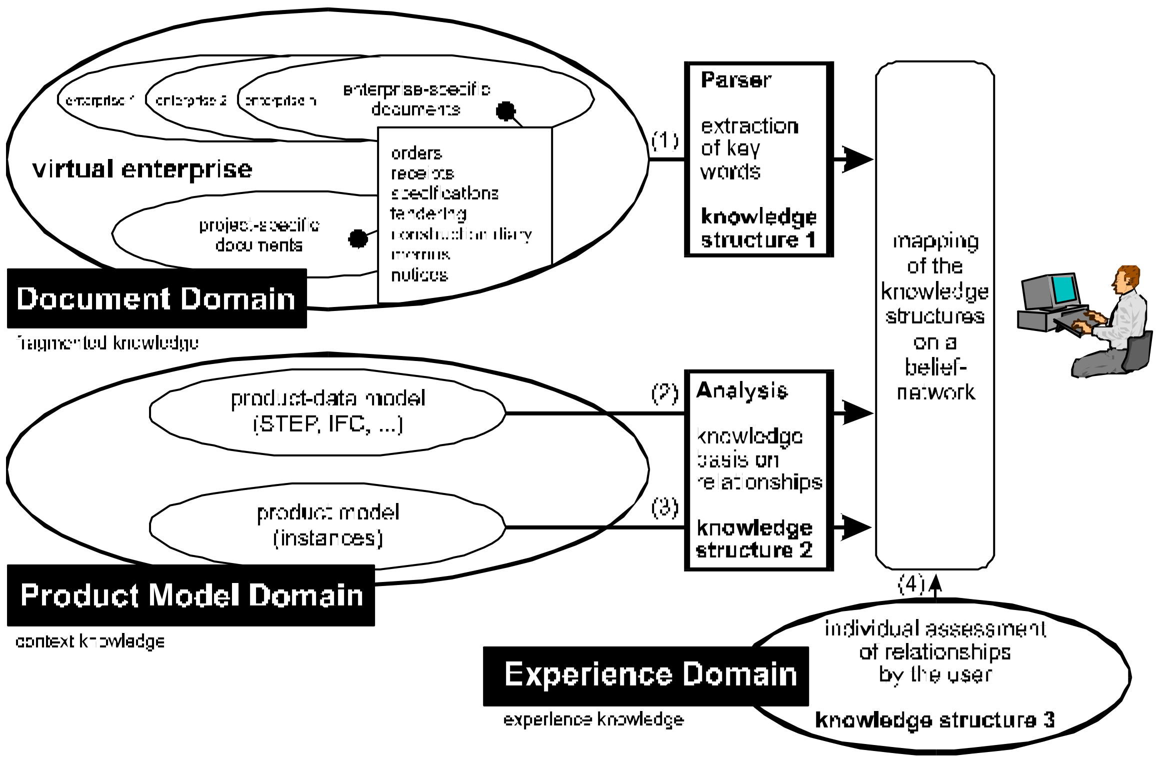
[1] The author was Scientific Assistant at the Braunschweig University of Technology from 1995 to 2000., where the project was carried out and will now be continued at the TU Dresden.

Retrieval of Project Knowledge from Heterogeneous AEC Documents

Karsten Menzel

Objectives

Although recorded in civil-engineering documents (such as construction diary, order forms, delivery notes, discussion memos, etc.), most of the knowledge experienced from a project turns useless without the interpretation by those people who were directly involved in the project, because they are the only ones who remember the context and inter-connections between the single elements of documents. Indeed, the single civil-engineering documents are fragmentary. If a way were found to retrieve all the context knowledge from the single stored documents, the entire knowledge and experience or at least a great amount of it would be available to everyone and could be used for planning and carrying out of future projects. Hence, the digital storage of the civil-engineering documents would be the long-term storage of the project experience as well.



The three-level architecture of the retrieval system

Approach

The method chosen comprises three sequential levels: On level 1, a preliminary object-oriented knowledge network should be extracted from the documents by applying general text analysis methods combined with clustering techniques. The necessary lexicons should be examplarily extended for the specific domain of AEC (Architecture, Engineering, Construction). On level 2, context knowledge should be provided, which has to be extracted from the knowledge structure of the product and product data model. It should be mapped onto the preliminary document knowledge network to refine this network and enhance its reliability. Nevertheless some uncertainty and fuzzyness will remain. This should be attached on level 3 by modelling this uncertainty explicitly by belief network methods. This allows that uncertainties are explicitly propagated during reasoning and that the user gets aware of these uncertainties. The final result of a query will be a list of documents representing this requested project knowledge, ranked by their reliability. The relationship between the documents can be visualized by knowledge maps, taking the reliability values as zoom factors, for instance.

Planning and Configuration of Processes for Site Installations

Steffen Scheler

Objectives

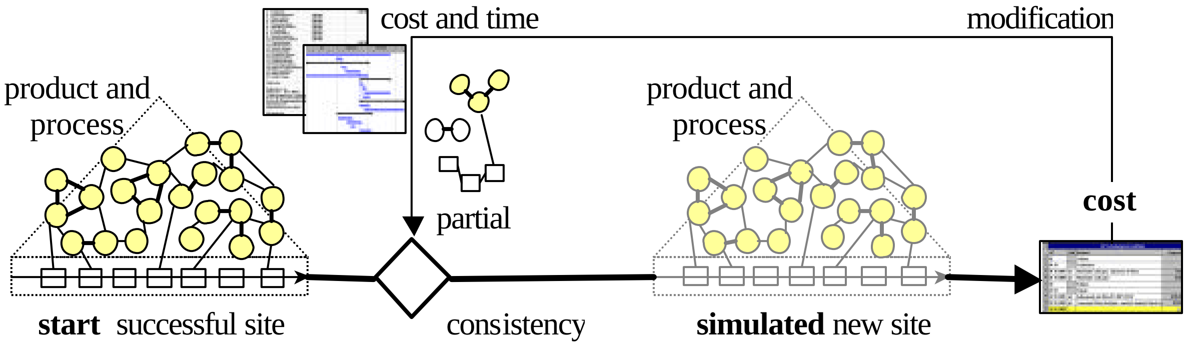
During the construction process, the design and layout of the *site facilities* are mainly influenced by the material flow. However, the material flow influences the overall construction management process as well. Therefore, it is of primary importance for the success of each project to ensure smooth and faultless workflows of the construction processes at the building site. In accordance with that, it is necessary to properly estimate and plan the relevant time and cost factors at the very outset. These elementary factors can be captured in an appropriate product model of the site facilities. However, the instructions defined by the contract planner determine only the value ranges which, in turn, influence the dimensioning of the site facilities. In order to instantiate properly the variable values a process model is needed.

The tasks of the site facilities scheduling are thus as follows:

a) definition of the type of the site facilities, and

b) the spatial arrangement of the site elements in accordance with the minimal transportation costs.

The haul roads are considered in conjunction with the cost and time factors with the help of a dedicated design tool. In order to include changes requiring spatial and/or temporal variations in the site facilities as well, it will be necessary to carry out a partial substitution of the initial product model, and not only simple changes of parameters. This makes the design tool act as a simulation tool. The goal is to maintain a consistent process model at any time. On the basis of a comparison of different alternatives it is possible to easily schedule the site installation costs depending on the construction progress.



Site facilities process model configuration for comparison of cost variants

Approach

The basic principle of the site facilities analysis is a distributed decision support system which cycles through the separate analysis subtasks, such as the (geometric) site configuration, the equipment level and the cost estimation, depending on the overall analysis goals set up according to the initially generated model structure. The start configuration is defined on the assembled from parts of successfully finished case projects selected by means of case-based reasoning methods.

The partial product models of the site facilities are linked with each other with the help of the process model. Through the integration of the time axis it becomes possible to separately consider objects that have multiple instantiations along the time axis, each time with different properties. However, these are in fact identical "real-world" objects which are distinguished only through specific time-related properties, such as the construction phase. This is realised by using the dynamic classification method. The priority or the classification of the individual objects can be changed at any time during the interactive process of partial analyses. Thus, through a relatively simple action, namely a partial model substitution, it gets possible to simulate a conceptual different alternative solutions. The consistency of the overall model can thereby be guaranteed through the respectively carried out re-classification of the involved product objects.

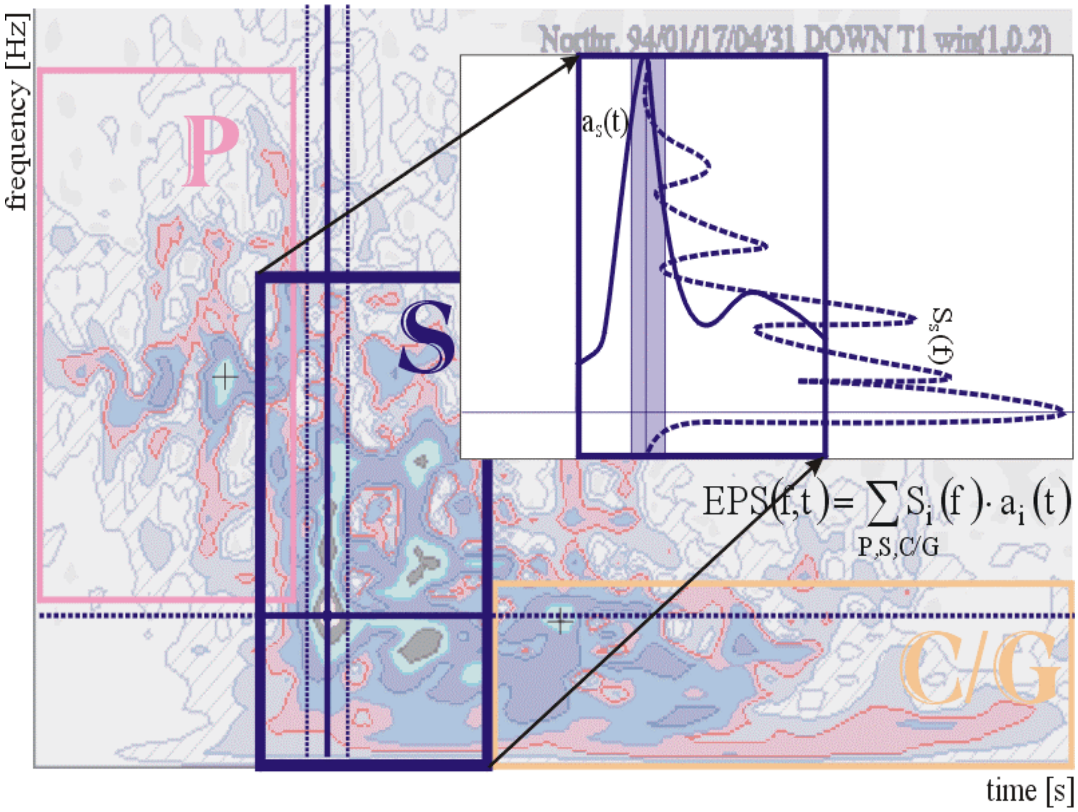
Nonstationary Empirical Load Model

Jörg Bretschneider

Objectives

Taking into account possible earthquake loads, as an essential part of structural design, is incorporated into the respective building codes of many countries. However, contemporary predictive methods, which are the base of earthquake load estimation, still depend on strongly simplified stationary models, which, if carefully investigated, reveal serious weak spots.

On the basis of a non-stationary stochastic model of the three-dimensional physical process of ground acceleration, these methods should be superseded by the frequency- and time-dependent, i.e., evolutionary power spectrum (EPS), predicted by means of empirical relations to topographic and seismic parameters for the most energetic acceleration component along the time-dependent stochastic principal axes.



Evolutionary Power Spectrum (contour plot), Empirical Load Model for one wave phase

Approach

In order to allow for the wave character of the complex natural phenomenon earthquake, the selected parametric model used to predict the evolutionary power spectrum consists of the load processes of three, partially overlaying wave phases, which are identified by means of the course of the time-dependent stochastic principal axes.

For each phase, load is modeled as an amplitude modulated stochastic process, whereby a product approach with different form functions (Kameda-Sugito, Yeh-Wen) for the amplitude modulation $a_i(t)$ is investigated. In order to get damping factors in a physically interpretable range, the spectral density functions $S_i(f)$ will be approximated by (multi) Kanai-Tajimi spectra.

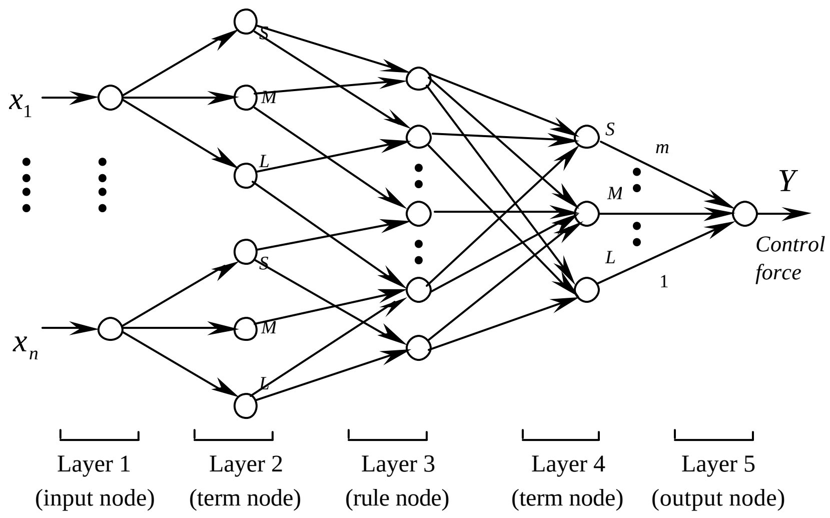
Suitable relations between physical factors, like local soil resonance, basin effects, magnitude and rupture duration, and parameters of the form functions will be empirically determined. The quality of the model will be estimated by response spectra comparisons.

Neuro-fuzzy Approach for Reduction of Dynamic Response of Seismically Excited Structures

Shumin Qiu

Objectives

Neural networks are models of information processing inspired by the biology of the brain. Fuzzy logic, as a knowledge based approach, performs an inference mechanism under cognitive uncertainties more like human's decision process. They are complementary technology. The focus of current research is on designing neuro-fuzzy based control algorithms applied to control seismic structural response which is the combination of neural networks and fuzzy logic and gives better performance than any one of them. In addition, to improve the performance of seismic control strategy, the characteristics of ground motion is included in the design of the seismic structural controller. In conventional control approaches, the effect of seismic excitation is ignored because it requires the prior knowledge of the future excitation in time history. This, of cause, is obviously not feasible in the case of a seismic event. Furthermore, the potential of the integration of fuzzy logic and neural networks will be explored in structural health monitoring applications.



Architecture of a neuro-fuzzy model

Approach

The research involves following tasks:

- Fuzzy rules acquisition and parameters evolution: The inference rules represent the intrinsic relationships between seismic excitation, structural dynamic response and control forces. In general, it is difficult to determine fuzzy inference rules, "IF-THEN" rules. To overcome the problem of fuzzy rule acquisition, neural networks are extended to automatically extract fuzzy inference rules from numerical data. The error back-propagation algorithm is used for tuning parameters of fuzzy neural networks.
- Effect of including ground motion characteristics in seismic structural control. An approach to incorporate the effect with an approximate filter, the output of which represents the ground motion with desired frequencies and damping characteristics. The resulting controller depends on the parameters chosen to define the ground motion characteristics.
- The numerical simulations are carried out using a multistory shear building model in which the control forces are applied through an active mass damper. The simulation is implemented by using the package of MATLAB/Simulink.

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), 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: Data management

Intended Audience: 4th semester, students of civil and structural engineering
Lectures and Tutorials: Scherer / Gerk
Subjects: Application of tables, linked tables and banks for structural engineering and construction management. Management of data and information. Introduction to data modelling and design of data banks. Examples are illustrated applying EXCEL and ACCESS software.

Title: Computer-Aided Engineering: Applications for Structural Engineering

Intended Audience: 5th semester, students of structural and civil engineering
Lectures and Tutorials: Scherer / Eisfeld
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: 5th 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: A 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, University 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, Planungs- und Ingenieurbüro für Bauwesen Radebeul, Schmitt Stumpf Frühauf und Partner München, Schultz & Basler Anwaltskanzlei Zweibrücken

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 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.

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 retrieved knowledge should be represented through knowledge maps.

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 we will concentrate the research efforts on the recognition of design differences in two and more domain models. Mapping methods will be extended and a mapping specification language for building construction will be developed, which is based on the principle of characteristic mapping patterns. We may benefit from recent development in multi-database systems when we make developments for the mapping and the consecutive matching.

Scholarships

Title: Active Control of Buildings
Financial Support: Scholarship by the State of Saxonia, Germany
Person Years: 0.5, Duration: 0.5 years
Approach: Application of fuzzy and neural methods to characterize the seismic load process and control the active control systems.

Publications in 2000

[1] SCHERER R., BRETSCHNEIDER J., Stochastic Identification of Earthquake Wave Entities, Proc. of the 12th WCEE 2000, Auckland, New Zealand, January 2000.

[2] REINHARDT J, GARRETT,Jr J.H.,. SCHERER R.J., The preliminary design of a wearable computer for supporting Construction Progress Monitoring, Proc. of the IKM Weimar, June 2000.

[3] SCHERER R.J., Retrieval of Project Knowledge from Heterogeneous AEC Documents, Proc. of the ICCCBE-VIII, Stanford, August 2000.

[4] WASSERFUHR R., SCHERER R.J., Distributed Management of Co-operative Design Processes, Proc. of the CIT2000 conference, Reykjavik, Iceland, June 2000.

[5] SCHERER R.J., Information Logistics for Supporting the Collaborative Design Process, Proc. of the Workshop Collaborative Design, Portuguese Pavilion at the Hanover Expo 2000, ed.: Manuel V. Heitor, Uninova Lisbon, 2000

[6] BRETSCHNEIDER J., SCHERER R.J., Non-stationary Reference Seismograms, Proc. of the XXVII General Assembly of the European Seismology Commission, Lisbon University, September 2000.

[7] WEISE M., KATRANUSCHKOV P., SCHERER R.J., Ein Modell für die Tragwerksplanung im Hochbau auf der Basis des IFC-Projektmodells, in: Fortschritt-Berichte VDI, Reihe 4: Bauingenieurwesen, Nr.163, Forum Bauinformatik 2000, pp. 118 - 124, VDI Verlag, Düsseldorf, 2000.

[8] GEHRE A., SCHERER R.J., Erweiterung der Wissensbasis für ein flexibles Entwurfssystem für Tragwerke, in: Fortschritt-Berichte VDI, Reihe 4: Bauingenieurwesen, Nr.163, Forum Bauinformatik 2000, pp. 143 - 150, VDI Verlag, Düsseldorf, 2000.

[9] SCHELER S., SCHERER, R.J., Textanalysemethoden für Baudokumente mit lexikalisch organisiertem Kontextwissen aus Produktmodellen, in: Fortschritt-Berichte VDI, Reihe 4: Bauingenieurwesen, Nr.163, Forum Bauinformatik 2000, pp. 17 - 24, VDI Verlag, Düsseldorf, 2000.

[10] SCHERER R.J., REINHARDT J., Requirements for navigation through drawings on wearable computer by using speech commands, Proc. of the 3rd ECPPM 2000 at Lisbon, A.A. Balkema, Rotterdam, 2000, ISBN 90 5809 179 1.

[11] SCHERER, R.J., GEHRE A., Approach to a Knowledge-based Design Assistant System for Conceptual Structural System Design, Proc. of the 3rd ECPPM 2000 at Lisbon, A.A. Balkema, Rotterdam, 2000, ISBN 90 5809 179 1.

[12] SCHERER, R.J., Towards a Personalized Concurrent Engineering Internet Services Platform, Proc. of the 3rd ECPPM 2000 at Lisbon, A.A. Balkema, Rotterdam, 2000, ISBN 90 5809 179 1.

[13] WEISE M., KATRANUSCHKOV P., SCHERER R.J., A Proposed Extension of the IFC Project Model for Structural Systems, Proc. of the 3rd ECPPM 2000 at Lisbon, A.A. Balkema, Rotterdam, 2000, ISBN 90 5809 179 1.

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