BERICHTE DES LEHRSTUHLES FÜR COMPUTERANWENDUNG IM BAUWESEN

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

INFORMATION

RESEARCH AND LECTURE ACTIVITIES

1998

December 1997

This brochure should serve as an information repository for all those who are interested in the research and development work under the way in applied informatics in building construction and structural engineering at the Dresden University of Technology.

The research of the institute has - due to historical reasons - two different branches:

Applied Informatics

and

Applied Stochastics

Applied Informatics is further devided into Data Base Technologies and Artificial Intelligence. The fields of application are mainly focused on design whereas construction is attached through research co-operation, at present.

The view of the brochure is directed to the future, i.e. what is planned to be done in 1998 based on the results achieved in 1997.

We want to attract all those who are interested in co-operation with us or in our experiences. What we have already achieved is published by papers and provided through research reports, which are listed at the end of the brochure for 1997.

The brochure also gives an overview of the current staff. Mr Steurer, who submitted his PhD thesis on crack propagation modelled by stochastic processes, left the institute in 1997 to join MAN Roland at Mühlheim near Frankfurt and two newcomers, Mr Scheler and Mr Thomann, both graduated in civil engineering, entered the institute in 1997 and Mr Müller who is also a civil engineer will join us in February 1998. Mr Hauser and Mr Zsohar intend to submit their PhD theses in early 1998. Therefore, further fluctuation is to be expected during 1998 and will result in a further rejuvenation of the current staff.

Furthermore, we kindly invite everyone to visit our homepage at *wwwcib.bau.tu-dresden.de*, which will continuously updated to provide the latest state of our research activities.

Dresden, December 1997

Raimar J. Scherer

Lehrstuhl Computeranwendung im Bauwesen

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Modelling Framework for Concurrent Engineering in AEC

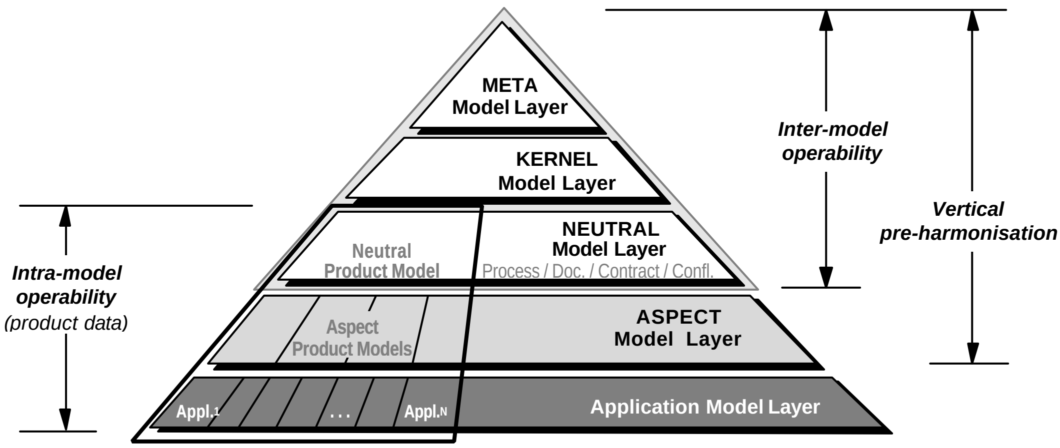
Peter Katranuschkov

Objectives

Concurrent Engineering Environments for AEC must take into account the distributed multi-discipline nature of construction projects, the heterogeneity of the used information sources and information processing tools and the specific requirements of the virtual enterprise, set up a new for each construction project. An important prerogative for the achievable functionality of the concurrent engineering environment is its underlying modelling framework which must enable: (1) information sharing across disciplines, with consideration of the different types of construction information (products, documents, processes etc.), (2) seamless integration of existing legacy software and (3) tackling of the technical and legal aspects of co-ordination and communication within the virtual enterprise in the process of concurrent work. The goal of this research project is the development of an interoperable modelling framework which satisfies the above requirements and can be used as a common basis for gluing together the separate components of the environment, such as product data management, document management, contract and conflict management, legacy applications (CAD, analysis programs, decision support systems) etc.

Approach

The modelling framework is developed on the basis of the product data technology of ISO STEP, using EXPRESS as common modelling language for all developed models. The structure and the content of the data models in the framework are defined in accordance with the current IFC project model specification (version 1.5), but with a different overall architecture, a more robust API specification, with clearly defined product data management services, and a set of modelling extensions for the support of important concurrent engineering issues which are absent in IFC, such as the definition of a contract model and a conflict management model. The layered model structure (meta model - kernel model - neutral models - aspect models - application models) allows to achieve a high degree of semantic pre-harmonisation on the basis of the common reference models at the higher levels of the framework.



Principal structure of the proposed modelling framework for a concurrent engineering environment in AEC

Intra- and inter-model-operability within the framework are achieved with the help of knowledge-based enhancements of the models and a set of interoperability methods which provide dynamic model management issues, such as the run-time mapping across the individual domain or discipline-specific aspect and application models, matching of model versions and identification of locally made changes, global model synchronisation and consolidation for co-ordination purposes etc. All model management services are defined on the basis of the requirement for distributed processing over the Internet using the client-server paradigm.

It is envisaged to demonstrate the prototype on the example of a real large scale construction project *(The New Munich Fair)* at the end of 1998.

Approach to a Methodology for Cognitive Architectures for Decision Support Tools in Civil Engineering Design

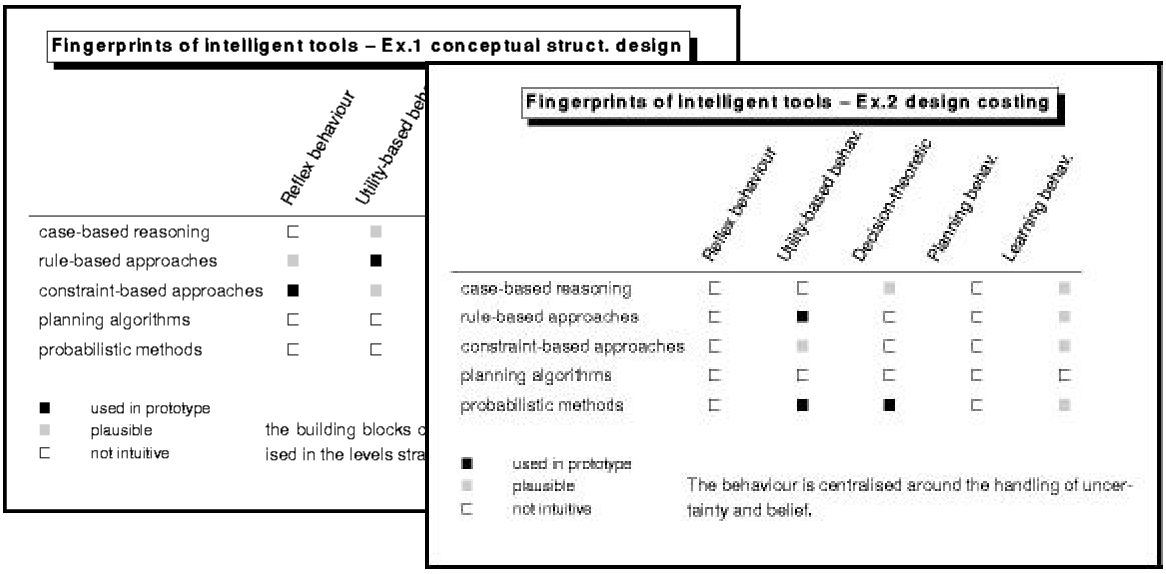
Markus Hauser

Objectives

Developments of knowledge-based tools for decision support in building and civil engineering design still remain isolated approaches without a strong methodological basis. In consequence the impact of Artificial Intelligence technology on the engineering practice remains relatively low and development efforts are often abandoned on an early prototype stage. This research aims at deriving a methodology for intelligent design tools. The methodology is build on the lessons learnt with past developments.
The objective is the systematic study, development and application of AI technology in building and construction to obtain a methodology for an enumerable set of architectures attached to specific problem categories in the civil engineering design domain.

Approach

Real design is too complex to be formalised with one single method. Approaches that combine multiple methods as e.g. neural networks and rule-oriented paradigms for structuring and initialising of the networks are more suitable. There, the general problem of appropriate architectures for such combinations arises. An intelligent tool is seen as the sum of its cognitive architecture and the corresponding computational design algorithms that implement the architecture.
We characterise cognitive architectures with associated behaviour aspects as reflex behaviour, utility-based behaviour, planning behaviour, decision-theoretic behaviour and learning capability. On the algorithmic level we consider computational design paradigms as case-based reasoning, constraint programming, planning, configuration and sub-symbolic techniques.
These characterisations enable us to do a twofold classification of applications in dedicated problem domains corresponding to their cognitive architecture and the used algorithms.



Examples for descriptions of intelligent design tools inside the methodology

The twofold classification allows the description of the cognitive features and properties of intelligent design tools in an abstract and comparable manner (simplified on figure above). Thus concepts and implementations of our own experience as well as systems found in literature can be uniformly discussed in order to derive a common methodology.

Process Model based Information Logistics for a Concurrent Engineering Environment

Rainer Wasserfuhr

Objectives

The information flow of construction projects should be improved to cover both intra-organisational and inter-organisational communication, in an integrated, goal driven process.

Information Logistics services should support this by hiding low level communication details from the users and give them specific views on a distributed information space. The services must support messaging and information sharing facilities on top of a secure communication infrastructure with scaleable bandwidth. The quality of communication contents should be supported by project wide abstract address spaces and integrity control of object references between distributed partial models across the network.

Approach

The developed Information Logistics Model can be divided into two models: the Process Model and the Communication Model, both represented in the STEP/EXPRESS modelling language:

Process Model: This model contains a description of the objectives and goals of the project, i.e. the reason underlying the flow of information, the functional units that can achieve these goals and the way they are composed. Therefore the process model provides the high-level decomposition of project goals into executable *activities*. Activities are described as expressions in a Concurrent Constraint Language, which can be interactively designed with a process modelling tool. The expressions contain all information about dependencies between activities, including real time constraints like *earliest_start* or *latest_start* conditions. On lower levels, the activities are mapped to work items of workflow engines.

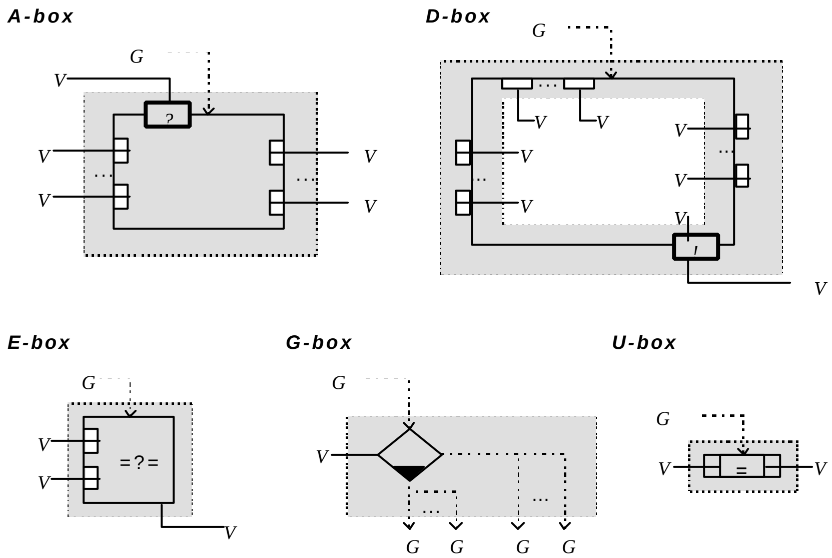


Figure: Primitives of a Visual Process Definition Language

Additionally, the process model takes into account references to product and document models, implicit processes given by product model schemata, (e.g. schema instantiation and concurrency control for transactions of shared databases), and process implications resulting from conflict detection and regulation checking.

Communication Model: This model describes, how activities of the process model are mapped to possible communication activities (like EMail, FTP, WWW or database transactions), executable on existing hardware, in a specific networking environment with specific communication protocols, compression and security techniques or file formats. The common description of communication is based on a CORBA oriented middleware layer, which relates communication events to an object-oriented model, including formal interface definitions, so that from all implementation and network details it can be abstracted towards a purely semantical description.

A Conflict Management Framework for a Concurrent Engineering Environment

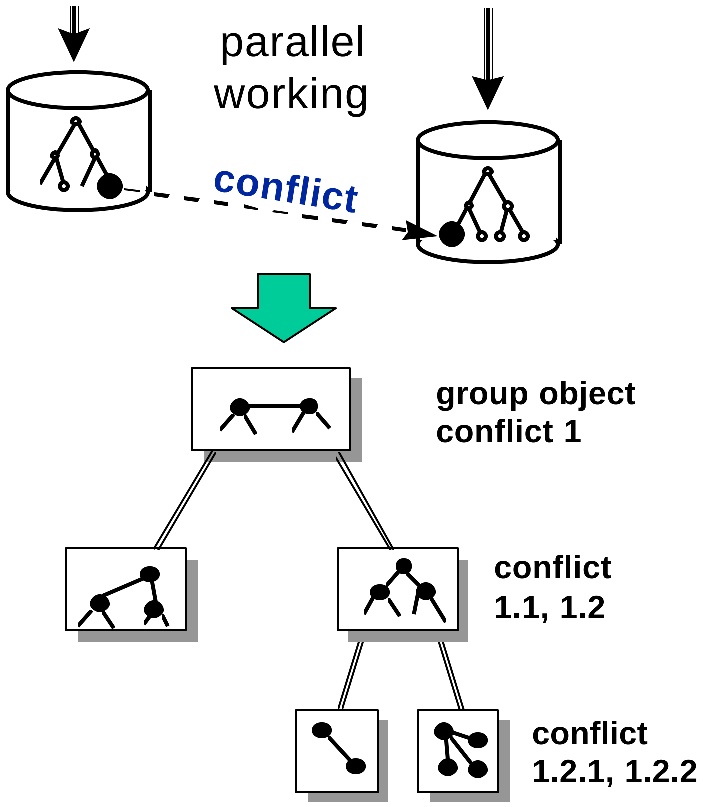
Dirk Hamann

Objectives

A conceptual framework is developed for conflict management in an open environment with different applications for the various domains of construction. These framework specifies the tools needed by the project manager to deal with conflicts in a proper way. The appropriate generic software tools for conflict management are prototypically implemented and demonstrated on a representative set of design and construction application tools.

In a multidiscipline environment of building design and construction there are various types of conflicts that routinely arise and have to be managed: *real-time conflicts*, *physical conflicts* and *multi-discipline functionality conflicts*.

The management of these various types of conflicts demands in turn the development of various types of conflict detection strategies and support mechanisms, such as: *geometrical reasoning*, *symbolic reasoning* and *requirements management.*



Approach

The conflict management framework works on a distributed product database with aspect models for specific disciplines. It monitors changes in the aspect models and keeps up-to-date information on required changes to the other, related aspect models. The dependencies between the different aspect models are kept in mapping and matching functions. Multidiscipline constraints and integrity propositions will be represented in meta object classes.

The gathered information are stored and sorted in a conflict database. The conflicting objects will be grouped in conflict groups. The conflict group will be divided in sub-conflicts, which then can be solved separately to reduce the complexity of the conflict resolution.

The responsible users will be advised on existing conflicts and will be requested to resolve this conflict in co-operation with the other users. The conflict database gives the project management an always up-to-date overview of the status of the conflicts in the project.

Product Information Systems supported by Case Based Reasoning

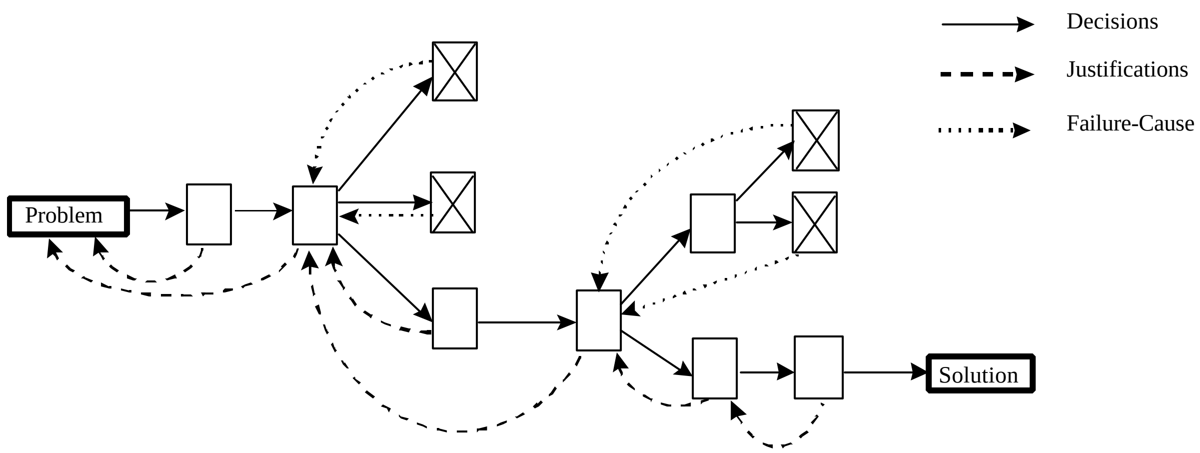
Jana Buchwalter

Objectives

A part of the daily design routine of architects and civil engineers is the search for information about prefabricated elements, the choice from a set of structural solutions and the application of data given by technical documentation and standards. But traditionally product information systems give more information than the user need and do not sufficient support the user during the search process. A considerable amount of intermediate information is produced in addition to the specific solutions. Therefore the aim of this research project is the investigation of solutions which will support the navigation process through the information system and provide the right information at the right time.

Approach

At present we are concentrating on the investigation of methods, which are based on concepts of case-based reasoning. The methods are capable of using specific knowledge of previously experienced concrete problem cases to solve a current problem and therefore to support the navigation process. A further important feature is the term of incremental sustained learning which allow to make immediately available new experiences for current and future problems. For example, the system can interpret a problem situation, generate a set of possible solutions or generate expectations in observed data.



A derivational trace

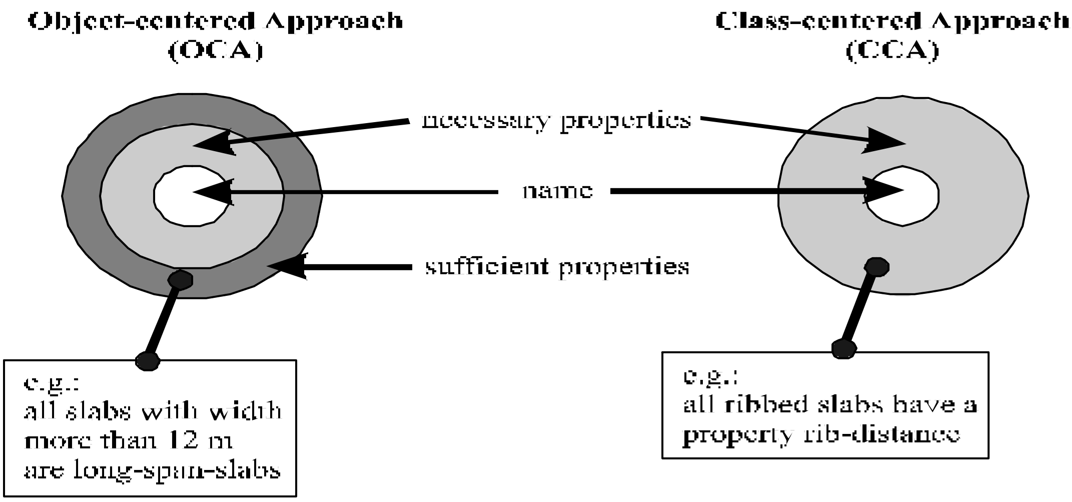
We use the term of analogy-based reasoning which builds a mapping between old cases and a new one and based on the transfer of past experience to new problem situations. If two situations, an older and a new one have some or certain things or features in common, they will likely have other things in common. We use especially the derivational analogy approach, which does not look for a similar solution like the transformational analogy approach but looks at how the problem was solved. It uses the previous derivations and all information about the solution methods and steps of the previous cases to solve the current problem. The derivational traces of similar past problems are replayed and where necessary modified to pattern a solution to a similar new problem. This approach makes it possible to realise an efficient structure of search and to support the navigation process by the narrowed space of solution. The use of knowledge of experiences will therefore significantly increase the efficiency of information systems.

A Product Information System with an Adaptive Classification Structure

Steffen Scheler / Markus Hauser

Objectives

Product data delivered by product information systems are a valuable property. However, without a classification structure the data are almost worthless, because the client is not able to find the data he needs. Therefore the classification structure of the information system is of upmost importance to support the client in his navigation process and retrieve the right data at the right time for the right problem.
A pre-given classification structure, as it is good practice in product information systems, means a predefined and fixed ordering of data and therefore a fixed representation of domain knowledge. It represents a particular instantiated search strategy and no longer - as it would be desirable - a generic search strategy. What we would like to have is a highly flexible, preferably adaptive classification structure, adaptive to the requirements of the particular searches, and flexible to the intention and objectives of the searching person.



Modelling of properties in the object-centred approach and in the class-centred approach

Approach

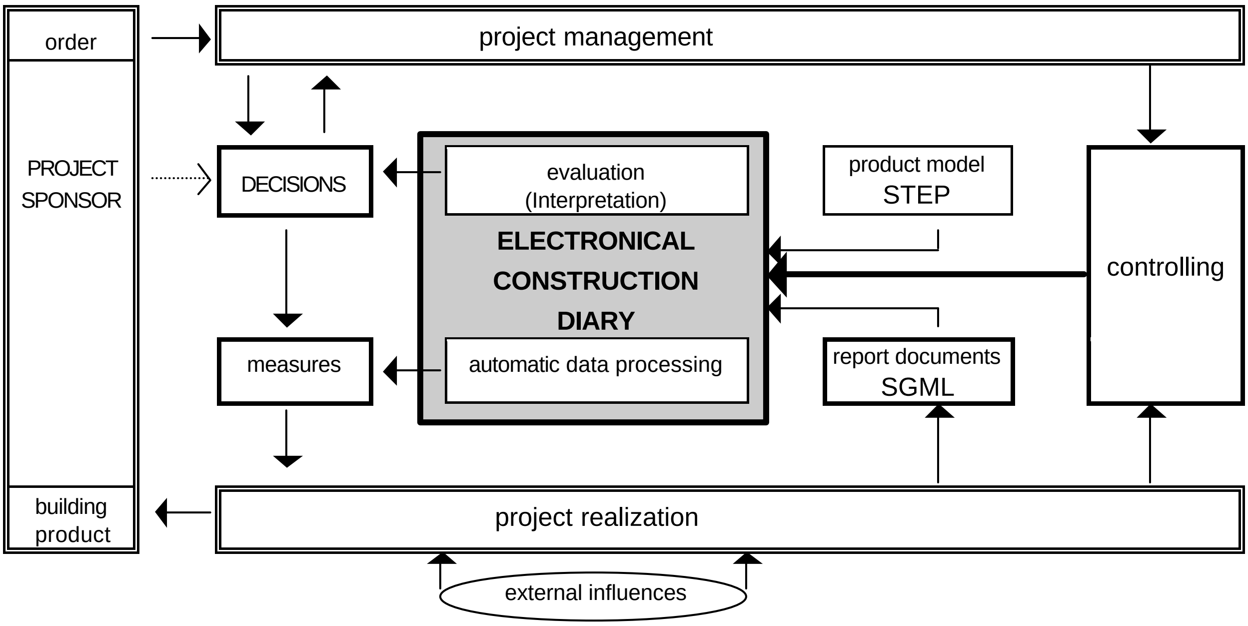
Product information systems provide information on products on the basis of attribute/value pairs. To be useful for a given design task this information has to be interpreted in specific engineering contexts. The gap between the pure data of catalogues and the reasoning context in the engineering task has to be bridged, and not only simply merged.
The context in which a product solution is evaluated and classified is dynamic and varies with the intention and objectives of the user. The task level, that classifies the product in categories associated with the actual design task, is one level of product representation.
An application example for product data selection with the object-centred approach has been implemented in a prototype system that helps the designer to select prefabricated slab elements for a given design task from a database. LOOM - a language and environment for constructing intelligent applications is used to implement the system. Declarative knowledge for product data retrieval is represented in LOOM and consists of definitions, rules, facts, and default rules. A deductive engine called a classifier utilizes forward-chaining, semantic unification and object-oriented truth maintenance technologies in order to compile the declarative knowledge into a network designed to efficiently support on-line deductive query processing.

The Intelligent Electronical Construction Diary

Steffen Scheler

Objectives

Presently, construction diaries are simple daily reports for giving evidence in later claims. Other documents, such as orders, receipts, notices, protocols, etc. exist besides the construction diary. Additionally, progress reports for the controlling department are established weekly or even only monthly by the engineer in charge for the construction site. Gathering this together we can realize that an electronically based construction diary - i.e. based on well developed data bases - can easily cover all these documents existing on the construction site and may become the central kernel of an information repository for the construction site. Furthermore, if we enriched this system by information flow and controlling functionalities we would come up with an information logistics and control system for the construction site, as illustrated in the figure below.



The electronical construction diary as the kernel for controlling and project management

Approach

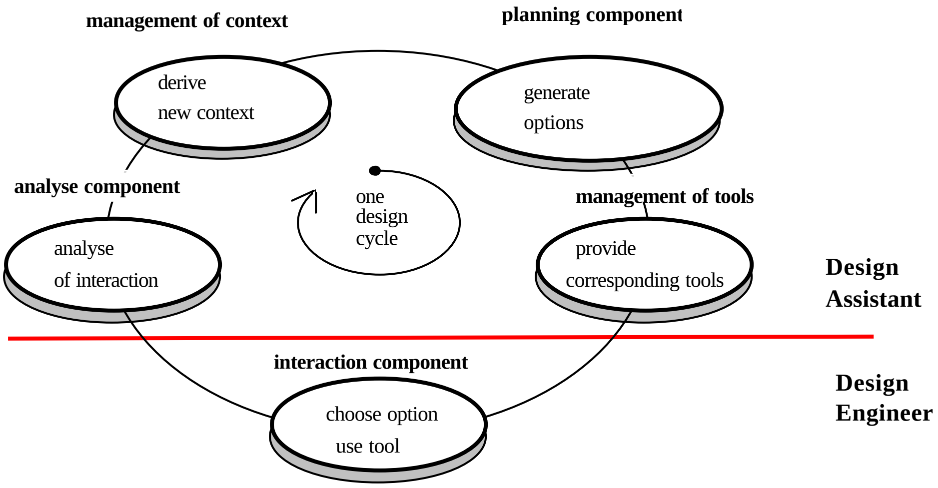
We concentrate our current research in this field on gathering, structuring and retrieval of the information to be found in the construction diary and other currently used documents and paper-based information. Our goal is the reliable retrieval of information in these heterogeneous documents. We apply a three-step approach, starting with text analysis methods, which are for instance used by the Alta Vista search engine and the Online Analytical Processing Methods, which are for instance implemented in ConText (@ Oracle Corporation) for a first estimate start-up of the inherent information structure in the document base related to a specific request. In order to improve the very vague results obtained by these generally linguistically based methods, which may already be sufficient for a general Internet search, we improve this information structure or network above all through the utilization of the knowledge contained in the product data models and the instantiated product model. This kind of knowledge can be deduced and transformed in a formalized way by applying interoperability methods, e. g. mapping and matching methods. As a second extension, we are investigating the application of believe network methods in order to cope with the still existing problem of the fuzziness and uncertainties inherent in such deduced networks of inter-dependent documents. As the end result, we come up with an ordered list of documents and paragraphs of texts of the documents, which are ordered according to possibility values established and propagated in the believe network. With this approach we intend to overcome the limits and inflexibilities inherent in the various existing Data Warehouse approaches.

Preliminary design assistant in structural engineering

Dietmar Müller / Rudolf Thomann / Markus Hauser

Objectives

The goal of this project is to develop a design assistant that supports the preliminary design in structural engineering. The design assistant starts from the architectural planning status and finishes before the final code-conform and precise structural analysis of a building. The prototype of the design assistant will focus on reinforced concrete skeleton structures.
Artificial intelligence methods are the basis of the mode of operation of the system. The specific method is the fulfilment of partial targets which are dynamically generated and hierarchically ordered. This is a non-linear artificial intelligence planning approach. The knowledge to generate partial targets is expressed in numerical and symbolical rules and in constraints. The product data model is represented in an object-oriented model. The mode of operation of the design assistant is interactive and shown in the figure below.



Interaction-cycle of the preliminary design assistant

Approach

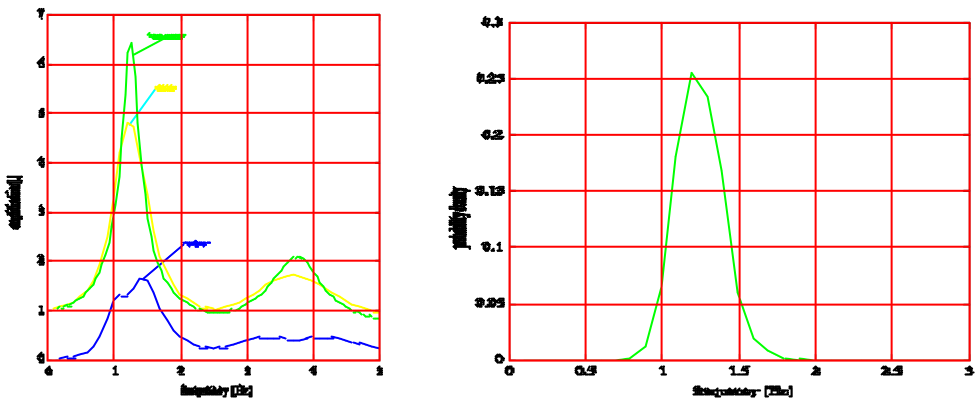
The design assistance system includes five components which are responsible for the consistency of the system and the continuity of the planning-operators (see fig.). The component for the management of the context describes the state of design. It contains the actually focussed partial targets and the already achieved characteristics of the structural model. The planning component generates alternative structural options applying only those planning-operators which are valid in the instantaneous planning context. The component of management of tools selects the appropriate tools to proceed in the structural design (e.g. selection and preliminary analysis of a column). These tools correspond to the alternative structural options. At this state the user is involved and has to choose an option and use a tool to carry on the design process. The interaction cycle is closed by the analysis-component which analyses the user action and actualizes the planning context.
This object-oriented model is dynamic in order to deal with the changes of structural elements while designing. The connection of rule-based and object-oriented knowledge representation is the frame within which the preliminary design is assisted.
The data architecture of our system is open, while based on ISO 10303, STEP. Therefore the data of the structural model can be transferred to other software systems in the design context. For instance a product information system could be a further application included in the design cycles.

Stochastic Amplification Function and Resonance Frequencies of Randomly Layered Soil

Martin Zsohar

Objectives

In the framework of earthquake resistant design of structures the prediction of the governing quantities of the seismic load process is an important research topic. Among these quantities the amplification function and the resonance frequencies of the soil are of special interest. Because of the uncertainties and the lack of information of the soil parameters they have to be modelled as stochastic quantities, which results in a stochastic amplification function and stochastic resonance frequencies.
The problem of determining the probability distribution of the stochastic resonance frequency is not solved yet. This is due to the fact, that this problem does not follow in a straightforward way from the solution of the stochastic wave equation, which is the stochastic amplification function. Additionally, the stochastic amplification function is up to now only solved for the mean value and for a stochastic wave velocity, although the layer thickness influences the resonance behaviour to the same degree.



Deterministic amplification with mean and standard deviation of the stochastic amplification function (left) and probability density of the first resonance frequency (right) of stochastic two-layered soil

Approach

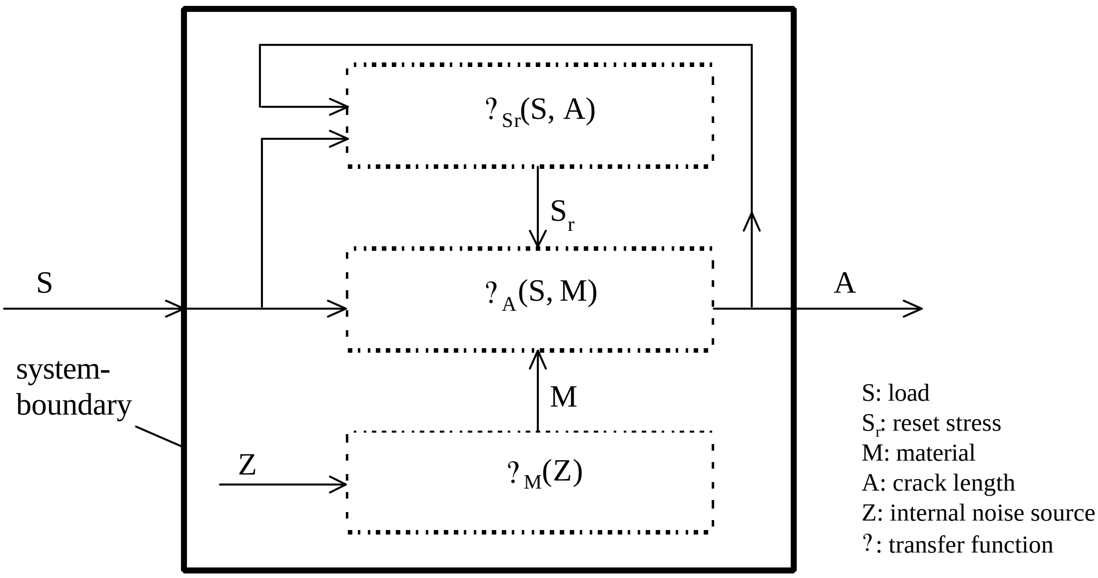
The assumptions for the solution of the stochastic seismic wave propagation problem are extended with regard to the existing models. First, not only the stochastic heterogeneous medium, i.e. to allow a variation of the elastic parameters of the soil pointwise, but also the stochastic homogeneous medium, i.e. the modelling of the soil as a stack of homogeneous layers, is examined. Second, as the stochastic approach requires an analytical formula, the amplification function is derived for an arbitrary n-layer model analytically. Third, the thickness of each layer is introduced as a random variable. With this extended basic assumptions we want to determine the probability distribution of i) the amplification function V(f) and ii) the resonance frequency F_0.
The two goals in question are strongly related to one another but do require different mathematical procedures. The first problem requires the solution of the stochastic wave equation for a boundary value problem. The smoothing perturbation method is applied and extended for this case. It allows an approximative solution for the mean value and the variance.
The resonance frequency of a layered medium is defined as the zero of the denominator of the amplification function. Only in the case of one layer this root can be given explicitly, the well known formula $f_0=c/(4h)$. This equation allows a direct calculation of the density function. For the general case a new technique, the so called discrete random variable model (DRVM) is developed. The basic idea is to interpret the resonance frequency as an implicit function of the random variables C and H. Then the probability distribution can be calculated with the aid of the distributions of C and H.

Modelling and Calculation of Fatigue Crack Propagation with a Stochastic System

Christian Steurer

Objectives

In nearly all engineering structures, e.g. offshore platforms, bridges, guyed masts, ships, aeroplanes etc., fatigue damage can occur. It cannot be avoided that such complex structures contain faults like voids, cracks, notches etc. from the beginning of their lifetime. These faults form the starting-point of fatigue damage. Therefore the engineer's intention is no longer to build up perfect structures but to cope with these kind of faults with the so-called Damage Tolerance Concept. The main thesis of this concept states that a fault can be accepted without any repairing activity as long as its future development is below a critical threshold. The problem with the Damage Tolerance Concept is that a reliable estimation algorithm is needed to predict the further development of a fault.
Many of these engineering structures are stressed by random loads like wind or water forces. Furthermore the material behaviour of such structures is varying randomly as the experiments of Virkler have shown.
In most cases these kinds of faults are cracks. For such pre-damaged structures a stochastic model is developed to predict the stochastic crack propagation, which takes into account both stochastic material inhomogeneity and random loads.



A structural component with a crack is modelled as a stochastic system

Approach

In the stochastic model a structural member with a crack is treated as a stochastic system. Its probabilistic behaviour results from a random load on the system and the intrinsic stochastic material behaviour of the system. These stochastic sources are modelled as the input of the system. The load sequence effects during the crack propagation which occur with stochastic loads are considered with a special reset stress model.
For mathematical convenience the system is transformed to a system which is excited by white noise sources only . Now it is possible to describe the whole stochastic system with a stochastic differential equation. The stochastic differential equation is analysed and a solution algorithm is developed which takes into account its special structure, a combination of additive and diagonal noise excitation.

Lecture Activities 1997/98

Title: Computer-Aided Solutions of Engineering Problems

Intended Audience: 1st semester, students of civil and structural engineering
Lectures and Tutorials: Scherer / Gerk
Subjects: Besides a general introductory guidance into informatics, this lecture comprise the fundamentals of hardware and software with a special emphasis on the programming language C and focuses on 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 as an example. Special emphasis is given to distinguishing between the topological, geometrical and the visualization model. Animation, technical drafting and symbolic visual representations 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. Furthermore, 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. It discusses basic CAD functionality, 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 AutoCAD. 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 / Moldenhauer
Subjects: This course of lectures introduces basic principles and techniques for the effective use of numerical analysis programs in the solution of various structural design tasks. It gives the students 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. 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 a concrete structural analysis package, 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: 8^{th} 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 on the basis of the international standard STEP and industrial standardisation activities like IAI/IFC. 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: 9^{th} semester engineering students with specialisation in structural mechanics
Lectures and Tutorials: Scherer / Hauser
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: 9^{th} 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.

Research Contracts 1996/97

Title: Spatial and Temporal Stochastic Modelling of the Seismic Excitation of Buildings Based upon a Seismological Oriented Analysis of Strong Motion Records with regard to Civil Engineering Needs
Financial Support: DFG Sche 223/11-1
Person Years: 2, Duration: 2 years
Approach: An extended database of strong motion records is analysed with the methods of evolutionary power spectrum and stochastic non-stationary principal axes. Simplified shape functions depending on parameters like soil conditions, receiver location and source are derived and empirically proved.

Title: Concept for archiving design knowledge, exemplarily studied for reinforcement design
Financial Support: DFG Sche 223/13-1
Person Years: 2, Duration: 2 years
Approach: Machine Learning methods are used to extract high-level design knowledge from reinforcement design case examples. The resulting design knowledge archive allows the re-use of generalised solution patterns. Thus the design experience associated with a given case solution remains accessible.

Title: Modelling fatigue crack propagation with stochastic differential equations considering inhomogeneous material behaviour and random loads
Financial Support: DFG Sche 223/14-1
Person Years: 2, Duration: 2 years
Approach: The propagation of an initial macro crack is estimated. The problem is modelled by a stochastic vector differential equation and numerically solved with direct stochastic integration methods of Runge Kutta type.

Title: Towards a Concurrent Engineering Environment in the Building and Engineering Structures Industry
Financial Support: EU ESPRIT Project No. 20587: ToCEE
Person Years: **41** (total), **8** (CIB, TU Dresden), Duration: 3 years
Approach: A conceptual framework and a supporting environment for concurrent engineering in the building construction industry is under development, using existing and emerging new advanced information technologies. The developed software prototypes will demonstrate the results by supporting co-ordinated management of product information, resources and document flow. The project contributes to the integration of design, construction and facility management. The workpackages are: *Design Process, Construction Process, Facility Management, Legal Model, Information Logistics, Product Modelling and Interoperability, Document Modelling, Conflict Management, Modelling of Design Standards and Regulations*
Partners: Obermeyer Planen+Beraten (Germany), Building Research Establishment (UK), General Construction Company (Greece), Kupari Engineering Oy (Finland),
E.Ott Lawyer Office (Germany), VTT Building Technology (Finland), SOFiSTiK (Greece), D'Appolonia (Italy), University of Ljubljana (Slovenia)

Title: Classification methods for products in building construction

Financial Support: GLOBANA Online GmbH and German Telekom
Person Years: 0.5, Duration: 0.5 years
Approach: Generic object structures and a dynamic re-classification method are developed. The results are verified for glass products.

Title: Case-based reasoning methods for the search in an object-oriented product data base
Financial Support: DFG Sche 223/19-1
Person Years: 2, Duration: 1 year
Approach: Using analogy-based reasoning mappings between old and one cases are built in order to transfer past experience to the new situation. Currently the research is focused on the derivational analogy approach.

Title: Knowledge-based design support for the design of structural systems
Financial Support: DFG Sche223/18-1
Person Years: 2, Duration: 2 years
Approach: Applying AI methods of constraint propagation and planning, where the planning operators contain rule-based knowledge, we support the synthesis of structural systems. The system is structured in three design levels: the strategic level, the tactic level and the reactive level.

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