BERICHTE DES LEHRSTUHLES FÜR COMPUTERANWENDUNG IM BAUWESEN

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

INFORMATION

RESEARCH AND LECTURE ACTIVITIES

1997

December 1996

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 wheras 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 1997 based on the results achieved in 1996, the human resources are available and the research and development contracts are on the table and are waiting to be continually extended and broadened.

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.

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 1996

Raimar J. Scherer

Lehrstuhl Computeranwendung im Bauwesen

(Institute of Applied Informatics in Civil Engineering)

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Object Oriented Service Library for Retrieving Product Data and Information

Jana Buchwalter, Christoph Nollau

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. The aim of the research project is the investigation of an organisation structure, which is based on advanced concepts of object oriented modelling techniques, for the re-use and retrieval of design solutions stored in a structural design service library.

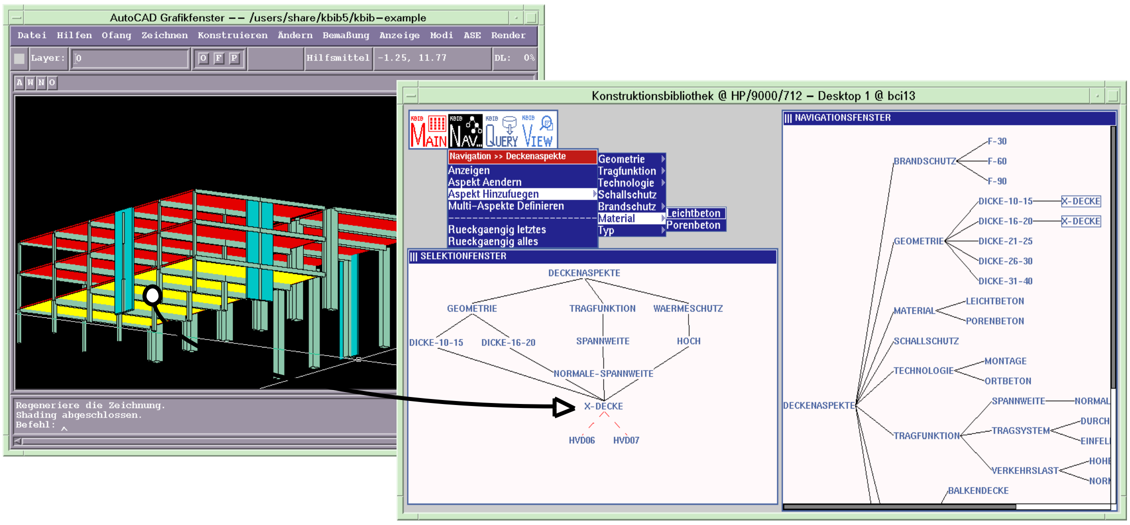


figure: Example for the integration of a structural design tool and object oriented library

Approach

The basic idea of our research is the connection of product data stored in a relational database, an object oriented knowledge base for the support of structuring and the navigation and user interaction by means of network communication and integration.

A dynamic **structuring** and classification of the product data should be realized by an object-centred approach. The objects from the relational database (description of prefabricated elements) will be classified to an object oriented hierarchy of the requirement and description classes built up in the knowledge base. Therefore each of those classes contains rules and attributes, which serve as a help for a classifier to assign the object-instances to the classes. As a result we get a dynamic association of product data with engineering knowledge implemented in the knowledge base.

The methods for **navigation** which we want to investigate for an actual information retrieval are the query by requirements and the query by example. A query by requirements should be supported by a forward-chaining rule system, which tries to narrow the solution space. The navigation with query by example supports the designer in finding similar solutions, maybe a better one, starting with a known solution for the design task.

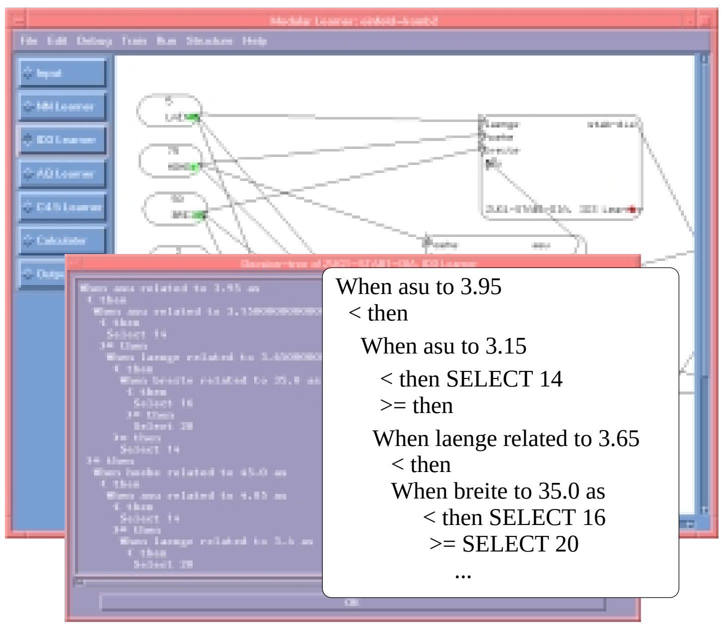
The process of **integration** of the product information database is essential for the use of the product data in the building design process. The figure above shows our approach and prototypical test for integration and data exchange. A description of the load bearing system of an industrial building including the geometrical constraints for the floor slabs which should be built as prefabricated elements will be imported in STEP format. Within the product information database, a valid solution which fulfils the given geometrical and load bearing constraints and further user-specified functions can be searched for. The complete product model (load bearing functions, physics related to design, geometry ...) of the chosen type of a prefabricated floor can be exported as a building model in STEP format for further design actions, for instance CAD drawing or cost calculation.

Automatic Knowledge Acquisition in the Reinforcement Design Domain

Markus Hauser

Objectives

Design knowledge in engineering comprises design rules, formulas for dimensioning, knowledge on critical points and knowledge about standards in varying degree of associated sharpness and certainty. Parts of this knowledge are general and static while other parts are dynamic and biased by experience and preferences of the designer. For computer-based support of design tasks this implies that the knowledge represented and referenced in programs cannot be assumed to be a priori fully accessible for hard-coding. Knowledge must be adapted dynamically to appropriately solve a design problem in a given context. The research goal in this project is to study learning algorithms and architectures for design systems in structural engineering. As a test-bed the domain of reinforcement design has been selected, i.e. the task of finding the reinforcement defined by its type, number of layers, bar diameters, bar lengths and bending forms corresponding to a given geometry and loading of a structural element.



Modular architecture and example for learned rule

Approach

Learning research in AI, computer science and psychology has studied and invented numerous algorithms for learning. In the domain of engineering design it does not seem advisable to train design functionality in one monolithic approach. We have identified the following reasons for this: 1.) to avoid unnecessary aggravation of the learning task, learning should be restricted to those parts of the overall functionality that are not a priori definable. The algorithmic knowledge – as available in wide areas of structural engineering design – can be hard-coded; 2.) different learning algorithms with different characteristic should be assignable to different sub-problems; 3.) knowledge dedicated to sub-task should be independently be accessible for inspection and tuning. In consequence we invent a modular architecture for learning. The modular architecture is derived from the data flow graph of the process model in the considered design domain. The nodes of the graph are interpreted as modules, that may either be instantiated as computation, input-/output or learning modules. Computation modules have a hard-coded functionality, while learning modules can be trained in their functionality with several *Machine Learning* algorithms. Edges in the graph model data flow between the modules. In contrast to the traditional control structure of procedural programs this architecture allows flexible adaption of the structure – which might be interpreted as background knowledge for a given process – corresponding to actual needs and performance considerations. By detailing the structure, the system can easily be augmented to increasingly complex functionality.

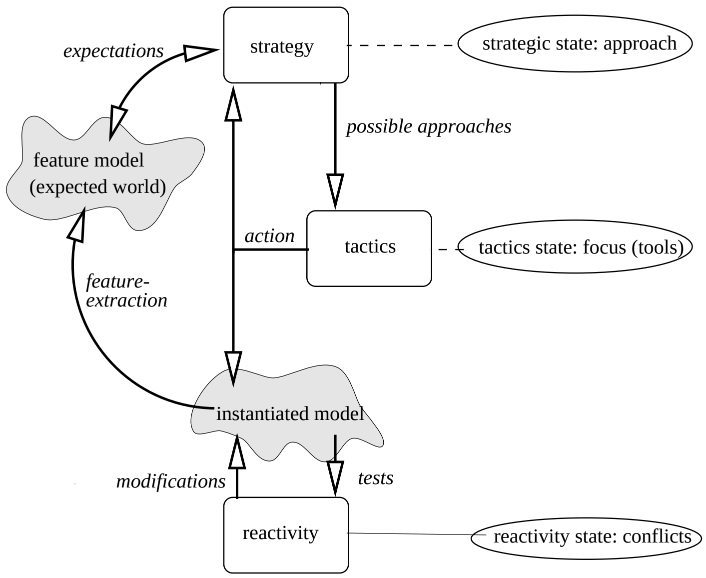
Cognitive Architecture for Conceptual and Preliminary Structural Design

Markus Hauser and Christoph Nollau

Objectives

A comprehensive formal computational framework capturing all aspects of design has not been provided yet, neither for engineering design in general nor for structural engineering design. It is too ambitious to promise yet again another general computational framework for (structural) engineering design. We would rather like to add another promising facet of design reasoning modelling which deals with reasoning level issues that are not yet satisfactory present in frameworks in literature.

As a test-bed for our approach we have implemented a design system for preliminary structural design. The design system serves as an assistant to the designer – architect and structural engineer as well – and helps to derive early conclusions on the structural system of a building and the dimensions of its main members.



Cognitive architecture of the design assistant

Approach

Structural design is the synthesis of structural systems and components in such a way that the system behaves as intended by the designer and meets the constraints imposed by physical laws and project requirements. The reasoning inherent in the design process is to be carried out on different levels and with different degrees of abstraction, uncertainty and impact on further design decisions. In this context we have identified three reasoning levels:

Strategic level Decisions of general nature concerning structural system types and sub-systems are made and the abstraction level is high. Reasoning on this level remarkably involves projection and anticipation.

Tactic level The degrees of freedom are limited by corresponding strategic decisions. In our modelling framework the concept of dedicated tools is used to model tactic design actions. Tactic design actions relate to the assignment of values to a focused set of design parameters, as e.g. cross-section dimensions or field-lengths. Design actions are embedded in the context of previously committed and further anticipated actions.

Reactive level On this level instances and models are rather detailed. Actions can be interpreted as reactions to other actions or as reactions to the presence of given types of design instance configurations.

Artificial Intelligence techniques are applied such as planning methods, heuristic search and constraint programming which are used in a distinct manner on the different levels. A prototype implementation took place in cooperation with several industrial partners – such as Leonhardt, Andrä and Partner, Stuttgart – from the structural engineering branch.

Interoperability of Heterogeneous Building Product Models

Raimar J. Scherer, Peter Katranuschkov

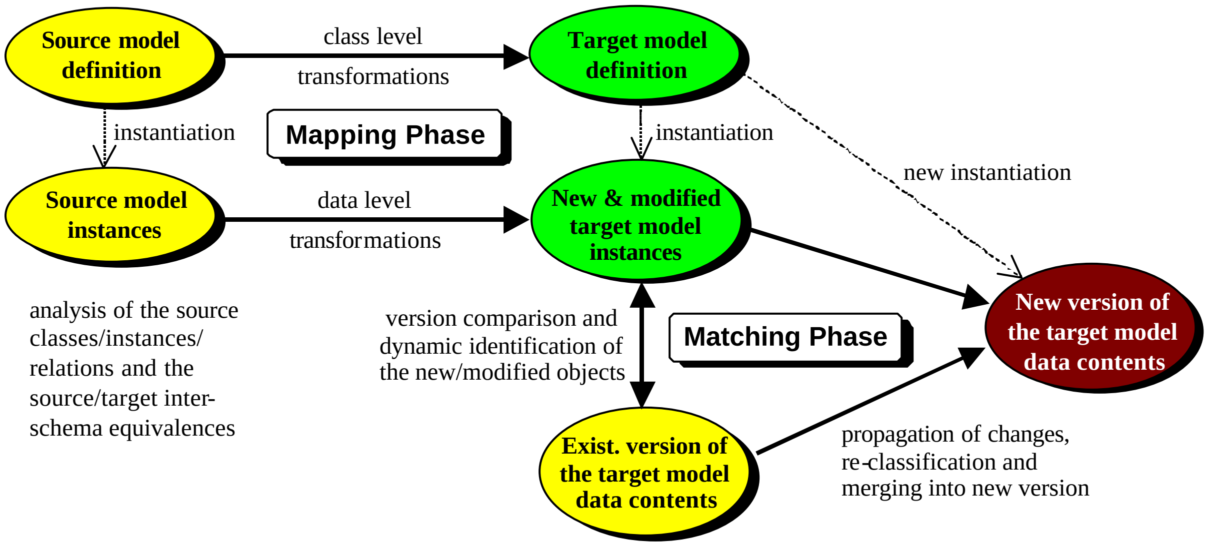
Objectives

In the realisation of open integrated environments for CAE/CIC various boundary conditions to product modelling have to be taken into account, such as the application of heterogeneous design tools, the use of different discipline-specific building object representations and the varying scope of data exchange needs depending on specific company, project or actor requirements. Therefore, integration approaches addressing the problem of *interoperability*, i.e. sharing of AEC information distributed among heterogeneous models and agents, are needed.

As part of the EU ESPRIT project ToCEE this research project aims at the development of generic methods focused on two key interoperability problems, namely: the data transformations between different partial product models, both on class and instance level, and the dynamic object identification, version checking and change management by updating existing model contents.

Approach

The proposed interoperability methods extend the STEP modelling methodology to allow information sharing even between a priori non harmonised partial product models (for example 'architectural aspect model' ? 'structural aspect model' ? 'HVAC aspect model'), each having its own adequate modelling object representations. The transformations between model classes and instances specified on the basis of STEP/EXPRESS schemata are realised with the help of two consecutively applied methods: schema mapping and object matching.



Schema mapping is a one-directional process that transforms (both fully or partially) the classes and instances contained in a source model to new target model classes and/or instances. The result of a mapping operation is a modified schema and/or a new context (instantiation) of the target model. For the formal specification of the inter-model equivalencies a specially developed mapping language following a declarative modelling paradigm is proposed.

Object matching involves a context-dependent analysis of the obtained new target model data, including comparison with older target model versions. The matching operations are applied only to the target model schema. They are based on knowledge-based rules for dynamic object identification and classification, which work on specially introduced meta-level object representations.

The schema mapping method encompasses functions for: analysis and parsing of the model structures and the inter-model equivalence specifications, expansion of instances and relations from the source into the target model and reduction of the generated new target model objects to eliminate redundancy. The object matching method encompasses functions for: dynamic identification and classification of the new target model objects, version comparison and identification of changes, execution of 'after-add' consistency checking rules, change propagation and re-structuring of the target model context to create a new consistent target model version.

Conceptual Framework for Concurrent Engineering

Peter Katranuschkov, Rainer Wasserfuhr, Dirk Hamann

Objectives

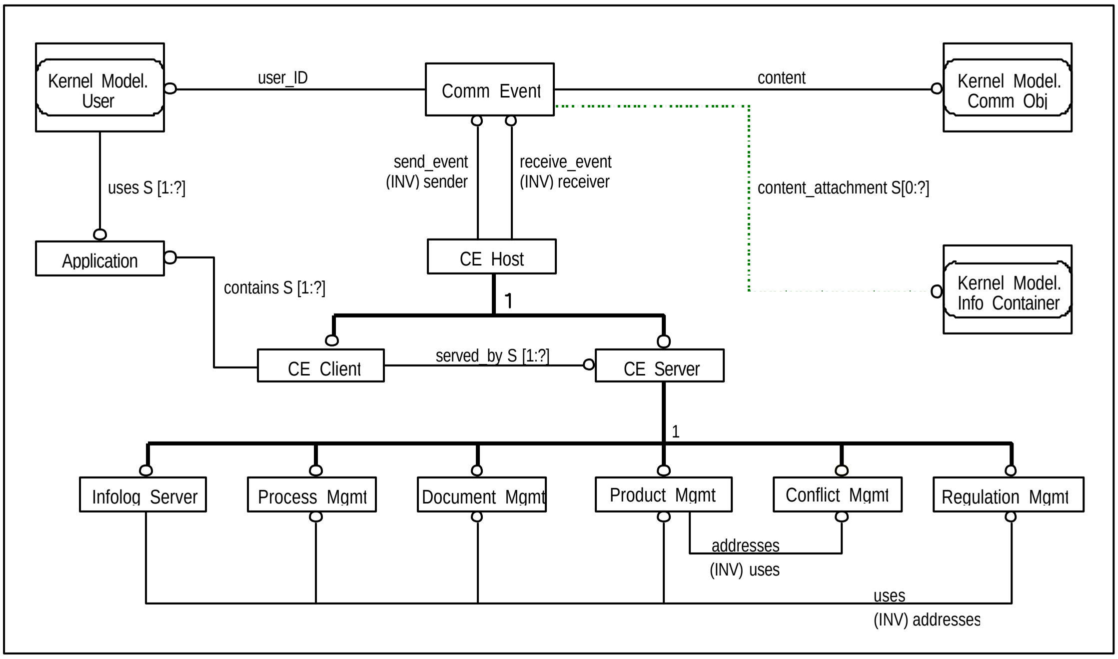
Integration is one of the prerequisites of concurrent engineering, but a concurrent engineering environment is more than that. It must support parallel work, version handling, conflict management, information logistics and building regulation management, and must be able to handle properly the legal aspects of inter-enterprise communication and information sharing.

This research project examines the requirements of a concurrent engineering environment from the viewpoint of the information needs of the engineering practice. Being one of the main coordination tasks in the ESPRIT project ToCEE it aims at the development of a conceptual framework which can glue together the concepts of process, product, document and requirement modelling into one logically coherent system.

Approach

The developed framework links together the heterogeneous set of process, product, document and requirement models with the help of special top-level kernel and meta information models. The first set of models is construction domain specific, whereas the kernel and the meta model are domain-independent and include generic concepts such as information container, information cluster, owner of information, version of information, server, client, agent etc.

Based on the requirements for an open and flexible system a „liberal“ distributed architecture is adopted. In this approach application systems are represented as clients, while the process, product, document, conflict and regulation management systems are allocated server functionality.



Principal components of the concurrent engineering framework

A central role in the framework plays the *Information Logistics Server* which controls, distributes and delegates all information management tasks. It makes use of the generic high-level entities Communication_Event and Information_Container which provide top-level access to all handled information items (product, document, process data), independent of their format and degree of granularity, for example single attribute, single object, STEP physical file, CAD drawing etc.

Inter-model-operability is achieved through the concept of *Views* with the help of knowledge-based functions for the model transformations, such as schema mapping and object matching.

An Adaptive Model of Communication for Transdisciplinary Cooperation

Rainer Wasserfuhr

Objectives

Modern communication media have been recognized to become of high importance for concurrent engineering, especially for transdisciplinary projects, which deal with heterogeneous data and have to cover different aspects of the life cycle of a product including design, construction, marketing and facility management.

A prototype is under development to derive conclusions from observed communication events to guide and support further communication between the participants of a project. The model should lead to a more context sensitive behavior of the communication infrastructure, based on the knowledge that is acquired during the project execution, but can not be available when the project starts.

A special focus is thereby given on the requirements in communicating engineering data, thus storing documents like technical drawings and relating them to shared product models.

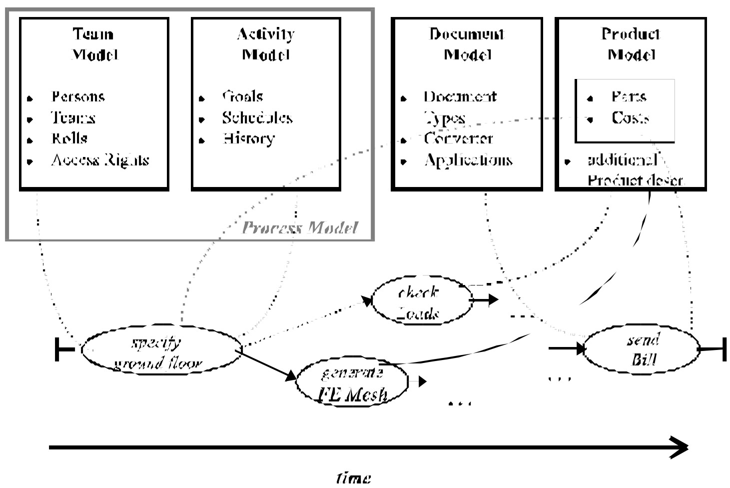


Figure: Semantics of communication events during the project history

Approach

The communication model is based on the description of atomic communication events, which can have the following properties:

- **Who?** Communication between teams of users including their organizational roles, legal and security needs and available communication infrastructure.
- **What?** Communication content, including file/document types, converters, versions and references to other documents and product parts.
- **How?** Communication channels including conventional and electronic communication media, their respective reliability, transfer capacities and transfer costs.
- **When?** Communication history and schedules.
- **Why?** Activity systems providing a team wide coordination of working plans.

The adaptivity of the model is achieved by defining ad-hoc extension mechanisms for any of the value domains of the above properties. By applying knowledge representation techniques like semantic networks, the value domains can also be structured taxonomically, e.g. for representing actor roles or activities on different levels of abstraction.
The integration of new values is supported by dynamic classification methods and the analysis of the frequency of usage of existing classifications.

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 information sharing, messaging and conferencing facilities, all 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 of object references across the network, like referencing of CAD block libraries, object linking in OLE and OpenDoc, or hypertext references.

Approach

The developed Information Logistics Model can be substructured 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 must contain the high-level decomposition of project goals into executable *activities*. Activities are used for both the documentation of executed activities and the definition, scheduling and distribution of planned activities (tasks). On lower levels, the activities are mapped to work items of workflow engines.

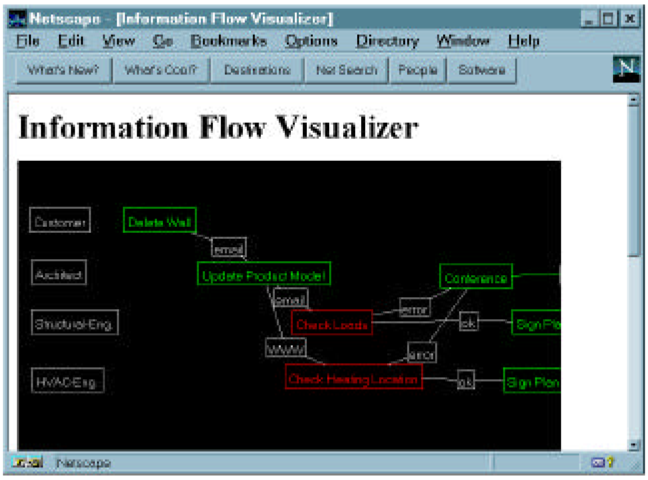


Figure: Internet based Information Flow Visualizer

The process model supports the *concurrent* execution of activities, because it describes, which activities are depending on each other and which activities can be executed independently, that is, concurrently.
The process model is also used as a shared task and activity space supporting co-ordinated scheduling of activities respecting the dependencies between individual activities, managing and updating task lists for users, and covering aspects of information sharing, like requests and notifications for locking and check-in/check-out of document versions.
Additionally, the process model takes into account implicit processes given by product model schemata, (e.g. schema instantiation), references to product and document models 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), executeable on existing hardware, in a specific networking environment with specific communication protocols, compression and security techniques or file formats.
Communication events are embedded into the process model by treating them as activities and managing relationships between them.

A Conflict Management Framework for a Concurrent Engineering Environment

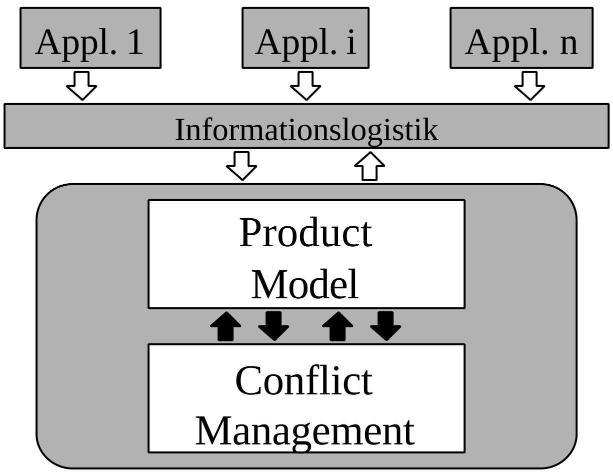
Dirk Hamann

Objectives

The primary goal is to set up a conceptual framework for conflict management in an open environment with different applications for the various domains of construction. The conceptual framework will define tools needed by the project manager to detect conflicts. The appropriate generic software tools for conflict management shall be prototypically implemented and demonstrated on a representative set of design and construction application tools.

In the 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.*



Conflict management in a concurrent engineering information environment

Approach

The conflict management framework works in close co-operation with the product model repository. From there it gets the information about the application scheme and the inter-relation with the other application schemes. Multidiscipline constraints and integrity propositions will be represented in meta object classes, and multidiscipline dependencies will be taken into account by querying the product model database.

The development is focused on:

- developing a strategy for conflict management in an open environment of independently acting agents,
- methods for representation of high-level inter-discipline constraints,
- monitoring methods for conflict detection,
- negotiation techniques between the individual agents.

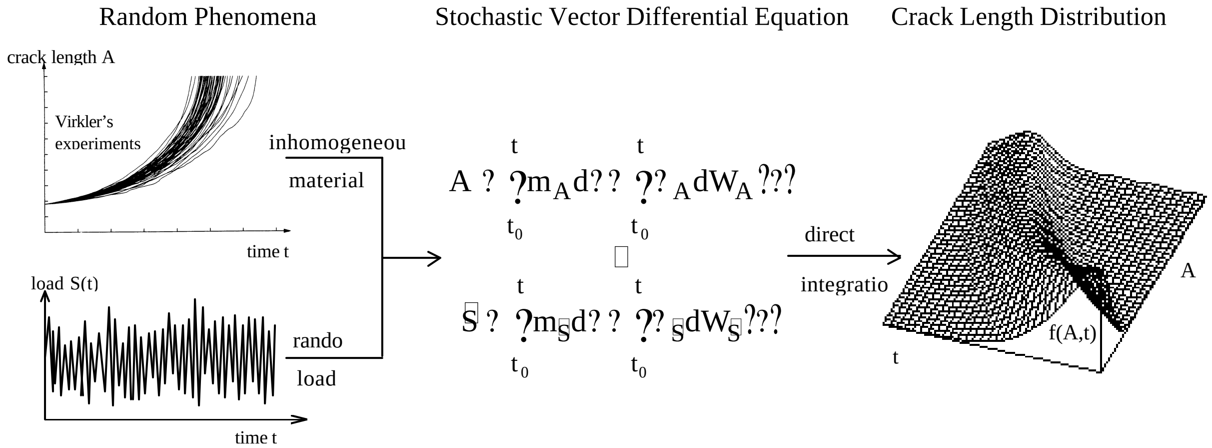
Fatigue Crack Propagation under Random Loads and Fluctuating Material Behaviour

Christian Steurer

Objectives

Fatigue models are used, if structures are exposed to varying loads beyond the elastic limit. In Structural Engineering they are necessary in order to estimate the reliability and the remaining lifetime of structures or structural members. The development of the crack propagation strongly depends on the nature of the load and the material properties. These quantities are randomly fluctuating. Therefor a stochastic treatment of the crack propagation problem is needed. The stochastic load sequence entails a complex crack growth behaviour. As a consequence the former load cycles have to be considered in order to calculate the present crack growth. This means that the stochastic material and load models have to be integrated into a crack growth law that reflects the physical phenomena in a sufficient manner.

A fatigue model is under development that takes into account both stochastic material inhomogeneity and random loads. The application of the model shall lead to realistic predictions about the development of the crack propagation and the remaining lifetime of the considered structural member. These predictions have to be compared to experimental results and direct Monte-Carlo simulations.



Modelling of random crack growth phenomena with a stochastic vector differential equation

Approach

Two models are developed: a widely analytical model and a numerical model. Both models are based upon the crack opening concept of Elber and use the reset stress as the central stochastic process, which reflects the effect of residual compression at the crack tip due to load sequence effects. The material properties are assumed as random variables and the loads as narrow banded stationary stochastic processes.

The kernel of the analytical model consists of the representation of the reset stress as a special first passage time problem of the underlying load process. The significantly correlated load cycles are collected into blocks containing the sum of the effective stresses of the cycles. The impact of the complete load on the crack growth is given by the sum of these blocks and leads directly to crack length distribution at a certain time. In contrast to the numerical models and many other models a little numerical effort is needed to compute the crack length distribution.

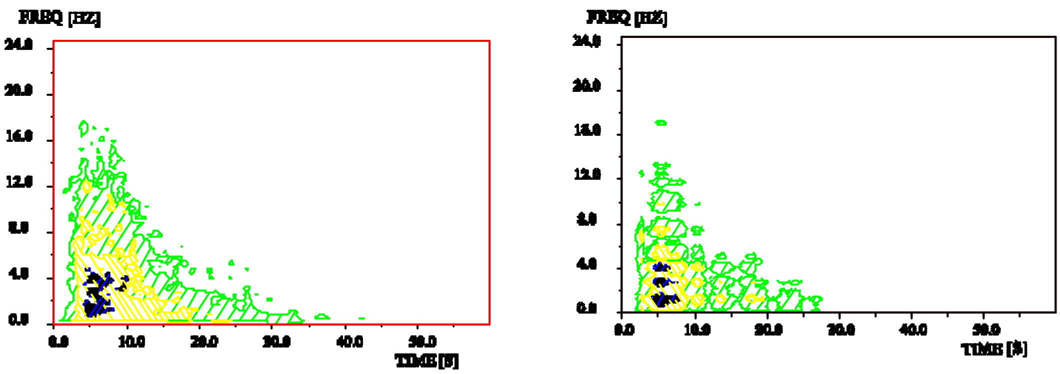
In the numerical model the complete stochastic system is presented by a stochastic vector differential equation that alleviates the calculation of the solution process because numerical schemes of stochastic analysis can be used. This method offers the opportunity of a synthesis of the two problems involved namely structural dynamics and crack propagation, respectively: The vector differential equation of crack propagation can be included in the stochastic vibration equations. The stochastic vector differential equation is solved with direct integration methods of the stochastic analysis.

Empirical Stochastic Seismic Load Model

Martin Zsohar

Objectives

The general models for the description of the loading case earthquake are unsatisfactory in many ways. This was drastically shown by recent earthquakes in Mexico, USA (Northridge) and Japan (Kobe). The major drawbacks of the valid models are that they do not sufficiently take into account non-stationarity, spatial correlation of the components and wave theoretical effects. In this project the spatial and temporal modelling of the seismic excitation process of structures is investigated based upon a seismological oriented analysis of strong motion records. Regarding civil engineering needs the evolutionary power spectrum allowing a high resolution in the time as well as the frequency domain is ideally suited. The main objective of this research is to find shape functions for the evolutionary power spectrum, i.e. to find a function depending on parameters like soil conditions, magnitude, epicentral distance, angle of inclination of the waves and predominant frequency and approximating the empirical spectrum with sufficient precision. The existence of such functions can be derived from the existence of shape functions for the related problem of strong motion duration.



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Isoline plot of the evolutionary power spectrum of the EW-component of Arleta Nordhoff Station record of 17Jan 1994 during the Northridge earthquake (left) and simplified synthetic spectrum (right)

Approach

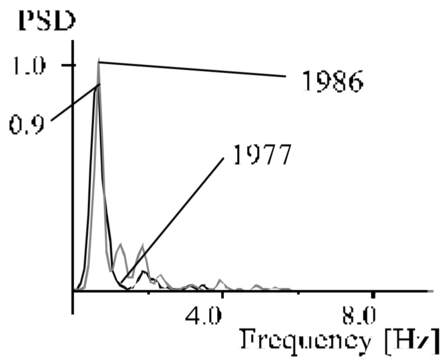
The shape function in question is modelled as product of a time and a frequency function. In the time domain the acceleration process can be separated into several wave phases. Therefore a method for the calculation of the stochastic non-stationary principal axes has been developed and implemented. It is used in order to separate and identify different wave phases, i.e. P-wave-, S-wave- and the last phase characterised by converted, diffracted and surface waves. This method is based upon the fact, that the different wave types are causing changes in the direction of the principal axes, e.g. P-waves are characterised by nearly vertical and S-waves by nearly horizontal principal axes for soft sediments. These time values, which limit the wave phases, are functions of the epicentral distance and the wave velocities of the transmission path from the source to the receiver. In the frequency domain the well known Kanai-Tajimi Spectrum (KTS) is extended to a Multi-KTS (MKTS) which represents i.e. the higher frequency ranges much better. The MKTS is adapted for each of the three wave phases. It depends on the initial value and the peaks of the spectrum. These parameters are functions of magnitude, epicentral distance and soil conditions. By simulating time series out of the synthetic evolutionary spectra the accuracy of this method is tested. This algorithm is applied to an extended number of records from the last North-American earthquakes and the aftershock series of the 1976 Friuli earthquake, in order to generalise the results.

Theoretical Stochastic Seismic Load Model

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, which can only be quantified in the stochastic sense, the *Eigenfrequencies of the soil, spectral shape, peak ground acceleration* and *strong motion duration* are of special interest. These parameters are mainly influenced by the local soil conditions. Soft soil for instance can amplify the amplitudes of the seismic accelerations to a great extent. Another great problem is the resonance phenomenon, which can lead to a concentration of seismic energy in special frequency ranges, as observed e.g. in Mexico during the great 1985 earthquake. This can have disastrous effects for man made structures, if these frequency ranges coincide with the eigenfrequencies of the structures.



Power Spectral Densities (bandwidth 0.25Hz) of strong motion record (NS) of INCERC-station during 1977 and 1986 Vrancea earthquakes in Romania

The main objective of this research is the prediction of the eigenfrequencies of layered random media in case of an earthquake occurrence. In general the local soil conditions, i.e. wave velocities, density, layer thickness and damping, are unknown. Consequently these quantities are modelled as random variables or random processes. This leads to the stochastic wave equation (SWE). Therefore the stochastic seismic load model is based upon the solution of the three-dimensional elastic SWE.

Approach

An analytical solution of the SWE demands a separation into a deterministic and a stochastic part. With the aid of the Green's function this results in a deterministic integro-differential equation for the first moment of the solution process. This equation can be solved numerically or analytically via the Laplace transformation. For the determination of the higher moments, which has not yet been done in the literature, an analogous equation is developed. Extending this work to the case of a realistic earth medium a layered halfspace is assumed, in which the thicknesses of the layers are modelled as random variables. This is done by incorporating them into the correlation function of the stochastic medium. Another new feature of this approach is the modelling of different soil parameters simultaneously. The results of this method are opposed and compared to the results calculated by a heterogeneous Finite Differences Method.

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: The calculation of 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 further propagation of an existing 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: An Adaptive Model of Communication for Transdisciplinary Cooperation
Financial Support: SMWK- 4-7541.82-0370/574
Person Years: 1, Duration: 2 years
Approach: The communication history (FAXes, EMail or database transactions) of cooperative engineering projects is observed and classified according to an dynamically updated semantic network. The semantic network allows decision support for the selection of communication activities in the future.

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 coordinated 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), Projekti Insinöörit (Finland), E.Ott Lawyer Office (Germany), VTT Building Technology (Finland), SOFiSTiK (Greece), D'Appolonia (Italy), University of Ljubljana (Slovenia)

Lecture Activities 1996/97

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: 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 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: 9th 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: 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 cooperative 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.

Publications in 1996

[1] LUNGU D., SCHERER R.J., Full-scale Measurements of Wind-induced Response of a 230 m RC Chimney, presented at the 3rd European Conference on Structural Dynamics, Florence 5-8 June, 1996

[2] ZSOHAR M., SCHERER R.J., Determining the Variation of the Eigenfrequencies of Layered Soil with the finite Differences Method, presented at the 3rd European Conference on Structural Dynamics, Florence 5-8 June, 1996

[3] ZSOHAR M., SCHERER R.J., An Approach for Determining the Eigenfrequencies of Random Soil with the Fokker-Planck Equation, presented at the 11th WCEE, Acapulco June 23-28, 1996

[4] HAUSER M., NOLLAU C., SCHERER R.J., Intelligent Design Tools as Product Model Interfaces, Proceedings of the CIB W78-96 Workshop Construction on the Information Highway, Bled, Slovenia, 1996

[5] KATRANUSCHKOV P., SCHERER R.J., Schema Mapping and Object Matching: A STEP-Based Approach to Engineering Data Management in Open Integration Environments, Proceedings of the CIB W78-96 Workshop Construction on the Information Highway, Bled, Slovenia, 1996

[6] HAUSER M., NOLLAU C., SCHERER R.J., A Generic Framework for Intelligent Design Tools, Proceedings of the ITCSED'96 Glasgow, Civil-Comp Press, 1996

[7] HAUSER M., SCHERER R.J., Application of Intelligent CAD Paradigms to Preliminary Structural Design, submitted to AI in Engineering Journal, 1996

[8] STEURER C., SCHERER R.J., Fatigue Crack Growth under Random Loading with Sequence Effects, submitted to Reliability Engineering and System Safety Journal, 1996

Reports

[1] KATRANUSCHKOV P., SCHERER R. J., Product Modelling Integration Environment for Design Tasks, Research Report 1/96, CIB, Dept. of Civil Engineering, TU Dresden, 1996.

[2] SCHERER R. J., SPARACELLO H.-M., COMBI Final Report, Research Report 2/96, CIB, Dept. of Civil Engineering, TU Dresden, 1996.