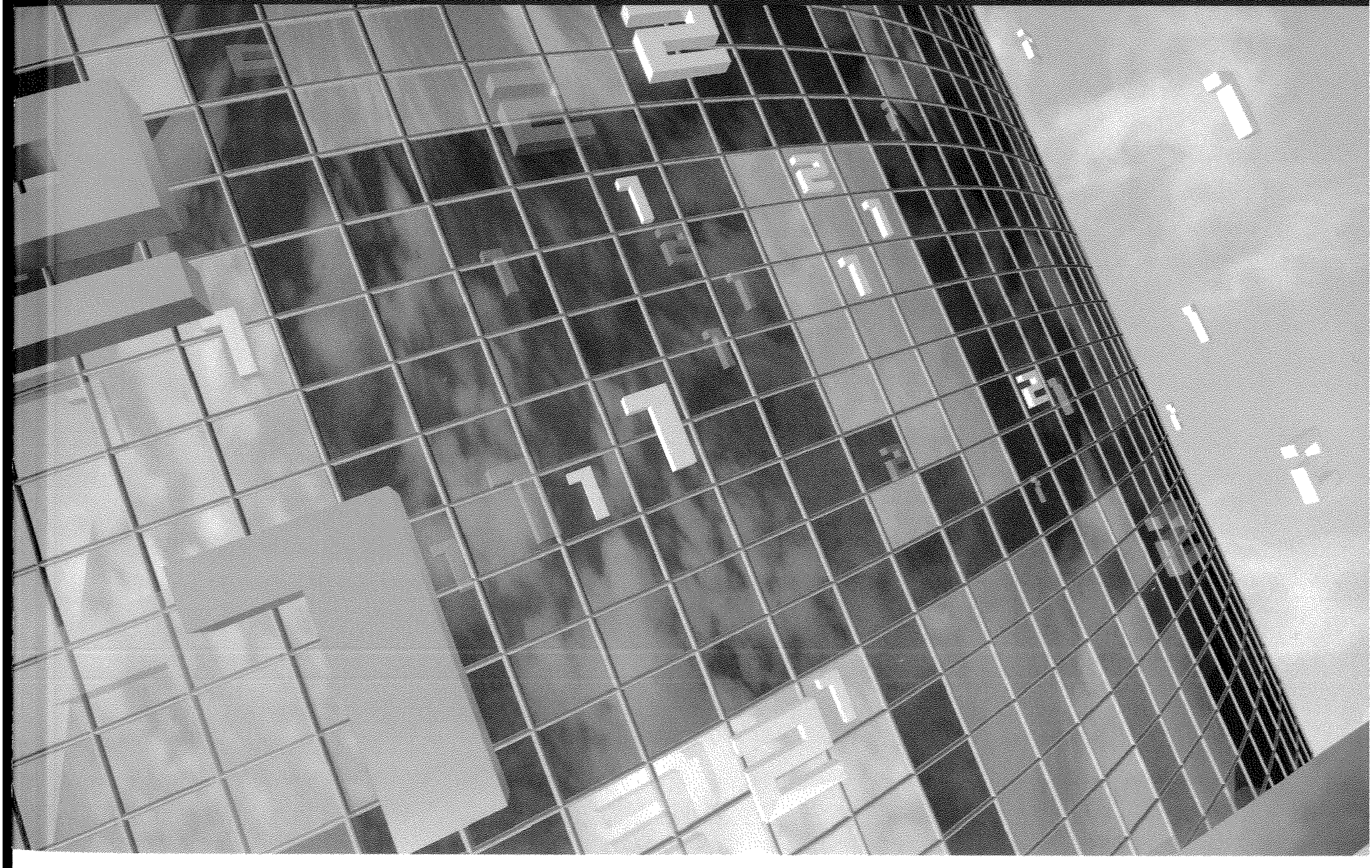
Matthias Kreimeyer
Udo Lindemann
Mike Danilovic

# Proceedings of the 10th International DSM Conference

Stockholm, 11 and 12 November 2008



KTH
ROYAL INSTITUTE OF TECHNOLOGY

JÖNKÖPING INTERNATIONAL BUSINESS SCHOOL
JÖNKÖPING UNIVERSITY

Produktentwicklung
Product Development

TUM
Technische Universität München

HANSER

Kreimeyer, Lindemann, Danilovic

**Proceedings of the 10th International DSM Conference**

Matthias Kreimeyer
Udo Lindemann
Mike Danilovic

# Proceedings of the 10th International DSM Conference

Stockholm, 11 and 12 November 2008

HANSER

*The Editors:*
Matthias Kreimeyer
Udo Lindemann
Mike Danilovic

Distributed by
Carl Hanser Verlag
Postfach 86 04 20, 81631 Munich, Germany
Fax: +49 (89) 98 48 09
www.hanser.de



Bibliografische Information Der Deutschen Bibliothek
Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.d-nb.de> abrufbar.

ISBN 978-3-446-41825-7


Production Management: Steffen Jörg
Typsetting: Karada Publishing Services
Coverconcept & -design: Atelier Frank Wohlgemuth, Bremen
Printed and bound by Digital Print Group O. Schimek GmbH, Munich
Printed in Germany

# TABLE OF CONTENTS

**Product Architecture Synthesis**

# CONTENTS OF THE CD

Enclosed with these proceedings you find a CD containing all papers in electronic form and trial versions of various DSM software presented during the tool session of the conference.

## ACCLARO DFSS

Axiomatic Design Solutions, Inc.

Acclaro DFSS is a suite of Design for Six Sigma (DFSS) tools including a full featured DSM module for planning and analysis. Partition, cluster and tear sub-matrices. Integrate DSM with a complete risk management suite to assess and mitigate project risk.

For further information, see http://www.axiomaticdesign.com

## LATTIX

Lattix, Inc

The Lattix Dependency Model allows to analyze an architecture in detail, to edit the structure to create what-if and should-be architectures, and then create Design Rules to formalize and communicate that architecture to the development organization. It allows to create a big picture view that is simple and intuitive and can easily be shared by a diverse group of stake holders such as managers, architects, developers and users.

For further information, see http://www.lattix.com

## LOOMEO

Teseon GmbH

LOOMEO is based on a generic approach to structure analysis and synthesis. It makes use of the principles of matrix and graph theory. On the one hand these enable the comprehensive analysis of cross-linked structures. On the other hand potentials for structure optimization can be highlighted by visualizing different perspectives and realized by applying adequate algorithms.

For further information, see http://www.teseon.com

## MULTIPLAN PROFESSIONAL AND COMPLEX PROBLEM SOLVER

Redteam

MULTIPLAN PROFESSIONAL is designed to support the management of single as and multi-project situations on project level and on portfolio level. It allows for DSM analysis to analyze and to simulate the introduction of new projects and consequences on other projects and resources. It is based on MS Excel. COMPLEX PROBLEM SOLVER enables stand-alone DSM sequencing and DSM clustering analysis within single domains as well as DMM clustering analysis between different domains.

For further information, see http://www.redteam.se

## P3 SIGNPOSTING

Engineering Design Center, University of Cambridge

The P3 Signposting process modeling software provides an environment for developing Applied Signposting Models. The Applied Signposting Model (ASM) provides a rich, graphical framework for constructing flowchart-style models to capture expert knowledge and develop process overview, to design dependency models to represent the elements in a domain and their complex interdependencies, to simulate and explore process behavior using 'virtual experiments' and to execute models. A Java runtime environment is necessary to execute P3.

For further information, see http://www-edc.eng.cam.ac.uk/p3

# LOOK AROUND YOU!

When you look at the economical development and growth of corporations and nations you see that it is largely based on innovations. Technological, product, process, organizational and societal innovations are the economic engines of development and growth. At the same time, innovation is the outcome of human commitment to their jobs, and in many cases their passion for technology, their quest for solving problems, their effort to achieve new outcomes, and their attempts to create new businesses. Yet, radical innovations in technology, products, process and organizations only achieve a breakthrough by leading to new situations while old ones are overthrown.

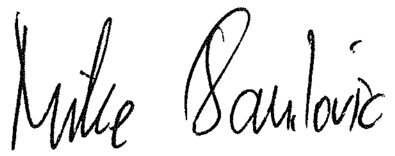
Innovations are based on ideas of people and their ability to communicate ideas across boundaries of organizations and nations, creating local and global networks where small innovative companies introducing new solutions can be suppliers to system integrators and end users. The key challenge for fostering innovations is the ability to coordinate the actions of people, to enable more efficient communication, and to integrate systems into cohesive product structures. All the while, the various actions of people in different processes have to be entrained, making use of their ability to overcome psychological and social boundaries of identities, political processes and power based interactions and traditions from different cultures.

Over the years, the complexity of products, organizations and processes has increased due to an increased variation of interrelated technologies that have to be integrated into final products and systems, variation of knowledge and people involved in diverse network settings and intertwined processes and magnitude of interrelated projects. Thus, the interdependencies among those domains have to be handled when product structures, organizational settings and processes are designed. To manage complex innovations of modern systems, the flow of information becomes maybe one of the most important aspects of enablers for creating innovations and diffusion of innovations of all kinds in new areas. Instead following traditions when designing, we have to find ways to follow the paths of information flow. That requires a new paradigm of how we approach design. The radicalism of this new approach is very similar to radical innovations in technology.

Matrix-based approaches that have been introduced more twenty years ago are demonstrating new means of focusing on interdependencies within and between different domains. We are now facing the challenge to cross the chasm between researchers creating those approaches and practitioners that need those approaches to solve their problems. To do so we need help from commercial software developers to produce easy software solutions based on DSM and DMM approaches. The DSM community has moved – over the years – from an introvert focus on research to an open community of collaboration. It is my dream that this open minded approach can help us to cross the chasm between research and practice and that we, as researchers, can develop new knowledge together with practitioners and to help develop new and more efficient solutions to the real life problems.

I welcome you all to the 10th DSM International Conference in Stockholm, Sweden.

Best regards



Mike Danilovic

# THE EVOLUTION OF MATRIX-BASED METHODOLOGY

Matrix-based methodologies to manage complex systems have come a long way. The Design Structure Matrix (DSM) has originated as a tool for the planning and management of projects and product architectures. Nowadays, it has turned into be a tool that not simply regards sequencing and tearing of a single domain, but which enables the user to interrelate multiple domains via Domain Mapping Matrices (DMM) and to model complete systems that comprise many different domains and relationship types (Multiple-Domain Matrix, MDM). Equally, elaborate software tools that visualize matrices as well as the underlying graph structures have evolved to a professional level. Thus, DSM and its methodological ideas have grown into a powerful methodology to work with complex systems.

Yet, there are numerous fields that still leave room for extending the current state of the art to a full means of complexity management and systems engineering.

The *models and structures* that are encompassed by matrix methodology are mostly limited looking into the constellation of elements and their relationships. However, there is no comprehensive list of structural patterns (such as clusters or cycles) that can appear in and dominate such structures. In the same way, there is little empirical evidence to what extent such patterns are actually valid and how they need to be interpreted in their specific context. As these structural patterns can actually co-exist simultaneously, little is known about how to treat their overlap.

*Matrix methodology* has come from mapping existing structures into a description that facilitates the analysis and understanding of networked structures. However, it has bypassed certain semantic possibilities that are available in other methodologies and that allow for a better description of complex systems. As such, there are for example:

- introducing logical operators (e.g. AND, OR, XOR, etc.) to complete the relationships between elements of a matrix (for example to describe alternative paths in a process or to document alternative variant designs),
- mixing levels of abstraction in a system (e.g. to describe the content of a single cell of a matrix by another matrix), and
- extending the modeling capabilities (e.g. by setting boundary conditions in a matrix or by linking elements of a matrix to the relationships instead of linking them to other elements).

Furthermore, methodology as such needs to be extended. Little is available about how complex systems evolve over time and how this can be managed using matrix-based methodology. While other disciplines, e.g. cybernetics or control theory, do have solutions to this end, their differentiation from and integration into DSM and its related methods have not systematically been evaluated. This is true for other topics that have been much researched in other disciplines, for example complexity metrics to measure, evaluate and maintain complex systems.

The *interaction with structures* is still only possible for experts. Managing a complete system set up from a number of domains often involves hundreds or thousands of elements and even more dependencies. While visualization and ergonomic support are available, the full power of intuitive interaction is still far from being fathomed. Three-dimensional technologies or intuitive "sensing" of structures using force-feedback mechanisms could be possible answers.

A number of well-established *tools* are available now. Still, most of the tools are tools for specialists, either limited to a specific domain or complex in their use themselves. A breakthrough into mass markets, comparable to the different tools that evolved around mind-mapping has not taken place yet. In general, it appears that the lack of access to existing network-data is a hindrance to enter the market.

Ultimately, there are many *applications* of DSM and other matrix-based methodologies waiting to be explored outside the popular sciences, such as the lifecycle of applying a DSM in a company, for example, or the actual use of matrices where we interact with networked structures without noticing it.

Nevertheless, it appears that both research and industrial application of matrix-based methodologies are on the upswing. This can both be seen in the number of publications and in the growing spin-offs that revolve around this particular field of science. We are very glad to see that this year's DSM Conference is continuing this course and brings a wide variety of novel ideas and concepts to support the progress of complexity management.

Matthias Kreimeyer

Udo Lindemann

# FROM THE REAL PRODUCT TO ITS ABSTRACT ARCHITECTURE AND BACK AGAIN

Product complexity has increased continuously over the past years, in particular for highly integrated products such as automobiles. This complexity also impacts processes, the structure of the company organization, the functional design of a product and its geometrical embodiment, and above all the communication among all those persons involved in bringing a product to the market.

Being able to manage a structure is a direct competitive advantage. In particular the identification and the making explicit of a system's interdependencies to visualize the architecture therein, may it be intended through design or having evolved historically, grant a competitive edge. Matrix-based methodology is a means of generating this transparency of a system's internal network, as it abstractly represents relationships and puts them into our grasp. This is the major strength in the industrial application of DSM, DMM and MDM, which appear to be on the rise in all sectors of industry. At AUDI, we are applying the methodology to interrelate functional and component architectures in automotive safety design, we use it to manage design processes and the communication between the different stakeholders, and we employ it to modularize different systems better. E.g. Modules are identified by relating functional and geometrical elements that are then clustered to identify sub-structures that can be turned into modules.

Yet, this level of abstraction is the downside of matrix-based methodology, too. While there are ample possibilities to abstract a product, i.e. to detach oneself from existing solutions, breaking ground back from the abstract description to a businesslike solution is much harder. In the end, the abstract outcome has to aid in finding concrete solutions that take shape as components, fulfilling one or several functions. Typically, engineers in a company think in terms of components or load cases. To help them, thus, relating elements alone is not sufficient, but it is necessary to bring concrete suggestions that help to that end. As such, matrix-based methodology is incomplete as long as it doesn't support the way back from the abstract level to a concrete solution.

From an industrial point of view, matrix methodology is on the right track. However, it needs to be made accessible for a wider clientele by not simply describing how to get to a better architecture but by showing tangible solutions that serve as best practices and that bring the abstract methodology more into the grasp of engineers. Only if it is possible to see how a methodology impacts a product geometry efficiently and intuitively, it gets accepted in everyday life.

Having followed the progress of the DSM community closely during the past years, I am glad to see that it has gained impetus towards a wider application. I am looking forward to see where this development leads us.

Sincerely

Ulrich Herfeld