Matthias Kreimeyer
Jonathan Maier
Georges Fadel
Udo Lindemann

Proceedings of the 11th International DSM Conference

Greenville, SC, 12 and 13 October 2009

CLEMSON UNIVERSITY
Product Development
the Design Society a worldwide community

HANSER

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The International DSM Conference is an endorsed event of the Design Society.

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Papers of the DSM Conference

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Tryout versions of DSM Software Tools

In the folder "DSM Tools", trial versions of some tools related to DSM are provided by the different companies. Please refer to the descriptions provided with each tool to see how you need to register or to unlock the tools.

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

ADePT Software
Adept Management Ltd.

ADePT Design 'Builder' allows complex projects to be defined in terms of the process steps and information exchanges. It then allows process sequences to be established using DSM methods, which identify key decision points in any process and areas of iteration. Strategies to decompose or 'tear' iteration can be identified and recorded in the tool. Finally, Gantt chart representations of the processes can be generated using tools such as Primavera and MS Project. From that point, changes can be made in either tool (ADePT Design Builder or the Gantt tool) and passed back to the other system.

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

Lattix
Lattix, Inc

The Lattix Dependency Model allows analyzing 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 creating 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

Structure 101
Headway Software

Using various visualization techniques, including DSMs, Structure101 lets you control the structural complexity of your code-base and ensure that it conforms to a defined architecture, making it less costly and risky to develop, modify, test, and deploy. Structure101 exposes structure, lets you define how it should be, communicate this to the team and know when architecture deviations make it into the mainline. A rich client, web application, RSS feeds and IDE plug-ins provide the right information at the right time to make architectural control easy on any project or process, local or distributed.

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

WELCOME TO GREENVILLE, SOUTH CAROLINA, WELCOME TO CLEMSON AND TO CU-ICAR

Georges Fadel
Clemson University

It is with great honor that my colleagues and I welcome you all to the 11th DSM conference, a conference that was born at MIT in the US, spent several years in Europe, and now comes back to the south-east of the USA. It is our pleasure to welcome you to Clemson University's International Center for Automotive Research or CU-ICAR, a center that was very recently established to focus especially on complex system, and on systems integration. In our particular situation at Clemson, we chose the automobile as the "vehicle" to teach and research approaches that deal with the complexity, but stress that the approaches are portable to any other industries. Thus, CU-ICAR is a perfectly suited location to host the DSM conference.

In these eleven years, the DSM went from a paper based approach to deal with complex systems to sophisticated software that enables practitioners to do much more than manipulate matrices. MDM – multiple domain matrices surfaced, graphical visualization tools flourished, what-if scenarios can be explored, and the DSM is becoming a very valuable method and tool to deal with the increasingly complex challenges of information management.

The conference provides you the attendee with three keynotes from academicians and practitioners. We have the honor to welcome Dr. Steven Eppinger, a person who does not need introduction in our community. He will give us his impressions on the progress DSM has accomplished during the years since he hosted the first DSM conference. Dr. Dan Braha, professor at the University of Massachusetts Dartmouth and affiliate faculty of the New England Complex Systems Institute will position our work within the challenges of dealing with complexity and will show his work on information modeling for large product design networks. Dr. Sean Callahan from the Boeing Corporation in Seattle will further develop the industrial needs in information management of large companies with product families and multiple evolving variants of these products. These three keynotes, two on the first day and one on the second, set the stage for technical presentations, presentations organized in two parallel tracks.

The technical presentations, your contributions to the community, cover methods, applications, and tools. We have attempted to balance the focus of the two tracks to allow you to gain as much as possible by attending one or the other tracks, but you will have ample opportunities to network and discuss issues with others, and, if so desired, to go from one session to the other. The parallel sessions were necessary to accommodate the various topics you proposed since the number of presentations continues to increase from year to year. We also have several tutorials offered by the software tool developers who continue to refine their programs and who, again, graciously provide you with fully functional copies of their products. Thus, we are confident you will enjoy the conference and have the opportunity to learn, to present your work, to identify new ideas, to reconnect with old friends and to make new ones.

We wish you a successful and productive conference, and welcome you again at Clemson and in Greenville.

Georges Fadel and the DSM organizers

DSM: DEPENDENCY AND STRUCTURE MODELING

Udo Lindemann and Matthias Kreimeyer
Institute of Product Development, Technische Universität München

The concept of using Design Structure Matrices is not new. In fact, method-based approaches have been employed in science and engineering ever since, with spreadsheets being, possibly, the most important tool in engineering.
Numerous methods have been developed that are strongly related to Design Structure Matrices, e.g. Incidence Matrices, Correlation Matrices, or Influence Matrices. Also, more complex methods in design rely on matrix-based methods; for example the House of Quality employs a set of Domain Mapping Matrices and a Design Structure Matrix.
In parallel, other approaches have been developed that are quite similar to the Design Structure Matrix. In fact, the Wassily Leontief Matrix (also called Input-Output-Matrix) has even been awarded a Nobel Memorial Prize in Economic Sciences in 1973 (W. Leontief: *Input-Output Economics*. Oxford: Oxford University Press 1966). It regards, essentially, the flows of goods between the entities of an economic system. Around it, a whole field of science of its own has developed.
Another example of a similar method is Gozinto's Graph, developed by Andrew Vazsonyi, but attributed to the fictional mathematician Zepartzat Gozinto, which is a malapropism of "the part that goes into" (pronounce this in English with a thick Italian accent, and you will understand ...), representing the decomposition of product architectures (S. Dvorák and B. Kropác: Decomposition of the Gozinto's graph with the use of a nesting store. *The Computer Journal* 17(3), 1974, pp. 245-248).
Furthermore, e.g. functional grammars, shape grammars, constraint-based reasoning, constraint propagation, and parametric modelling have many links to Design Structure Matrices, as they focus on how the interdependencies within a system can be managed methodically and with a certain purpose.
Yet, the brand name "DSM" has been well established for many years, especially in engineering communities, and the principles the DSM and similar methods are based on has proven valuable and viable throughout numerous applications.
Nevertheless, much can be learned from other sciences. Group Technology, for example, is able to employ Boolean Operators as part of the algorithmic analysis and synthesis of production structures, and the weighing factors that are used in Input-Output-Matrices are have received much attention to detail the flows of goods among the entities represented in such models. To this end, much can still be adapted from these approaches, and, similarly, other dependency models can grow much by adapting learning effects from DSM. The recent years have confirmed this trend, as e.g. the representation of DSMs by using strength-based graphs or the application of numerous algorithms from graph and network theory has shown.
The common denominator to all of these fields and applications of science is the interest in models, methods and tools for dependency modeling and the structural patterns that govern them. So far, there seems an abundant set of methods that represent the different kinds of dependencies and socio-technical systems, and to our knowledge, no comprehensive overview is existent. Similar, the term "structure" is used in all sciences with different understanding, although all attribute it the idea of patterns that are related to certain semantics.
Our proposal is to extend the scope of DSM into this direction – to open up our understanding of the capabilities of DSM, to promote its use and advances in other fields of science, and to foster the progress and application of dependency modeling and the specific understanding of structures and their relation to a system's behavior outside the DSM community.

In conclusion, it is good to see that DSM is one of the essential parts of engineering, and it appears to be on the right track. We are very happy to see that the DSM Conference 2009 brings about many novel ideas and is able to contribute to the exchange among researchers and practitioners towards a broader understanding of (not just) Design Structure Matrices.

Udo Lindemann

Matthias Kreimeyer