

Report from Dagstuhl Seminar 16192

Supporting Organizational Efficiency and Agility: Models, Languages and Software Systems

Edited by

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Abstract

Organizations are complex systems that need to respond to a variety of changes while operating in a dynamic environment. They involve multiple stakeholders each having a domain-specific perspective that relies on concepts and languages relative to individual information-centric processes, which may lead to undesirable side-effects such as scattered and fractured knowledge about goals, strategies, operational processes etc. This inter-disciplinary seminar analyses how the design, operation and maintenance of organizations can be supported not only with managing their resources and processes efficiently, but also with coping with the digital transformation.

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1 Executive Summary

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Organizations are complex systems that need to respond to a variety of changes while operating in a dynamic environment. They involve multiple stakeholders each having a domain-specific perspective that relies on concepts and languages relative to individual information-centric processes, which may lead to undesirable side-effects such as scattered and fractured knowledge about goals, strategies, operational processes etc.

Organizations are increasingly penetrated by software: Processes and resources are digitized, decision making relies on data provided by software systems, and transactions with external stakeholders are performed by machines. On the one hand, the omnipresence of digital systems creates the opportunity for further automation: The more structures and processes that constitute organizations are represented in software, the greater the scope for computer-supported management. On the other hand, this omnipresence creates a substantial challenge: Many organizations lack the competence to cope with the further



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increasing complexity of IT infrastructures. This includes the problem of assessing the business impact of IT investment and of assigning IT costs appropriately.

In addition to these problems, organizations face a tremendous challenge: The digital transformation will eliminate many existing business models. It will enable new products and services and it may require organizations to substantially change the way they do business. Only, if organizations are prepared to cope with this challenge, will they be able to benefit from the digital transformation instead of suffering from it.

A key aspect of the digital transformation is automation. While the potential for further automation through software is especially obvious in industrial production, other areas such as administrative work, management, and professional training are more and more dominated by machines. Therefore, there is need for new ways of supporting enterprise agility through the use of integrated computer-based systems

This seminar analyses how organizations can be supported not only with managing their resources and processes efficiently, but also with coping with the digital transformation, a topic which is subject of various research fields including: Management Science (a rationalist perspective); Organisational Studies (including Psychology and Sociology); Information Systems; Software Engineering (including modelling and meta-modelling, big-data and self-adaptive systems); Requirements Engineering. Even though there is an obvious correspondence of foundational assumptions, there is hardly any exchange between these fields: an issue that the seminar aims to address.

Against this background, the seminar is based on the following assumptions:

- Organizations are prepared for change only if they account for the challenges related to adapting their software systems as well as the peculiarities of social change.
- Research on organizational change in general, on designing organizational software systems in particular, recommends not only ideas of how to make organizations more efficient, but of how to make them a better place to work and live in. Otherwise it will be hardly possible to develop advanced conceptions of future organizations that may serve as an orientation for change. Without respective considerations efficiency remains a fairly meaningless concept.
- Support for organizational efficiency and change recommends cross-disciplinary collaboration. While all three research streams outlined above focus on important aspects, none of them is sufficient on its own.
- Support for organisational decision making is currently very difficult due to the tacit nature of knowledge that must be reified and processed using advanced technologies.

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3 Overview of Talks

3.1 Social Contexts and Individual Factors in Enterprise Modelling

Balbir Barn (Middlesex University – London, GB)

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Main reference B. S. Barn, R. Barn, F. Raimondi, “On the role of value sensitive concerns in software engineering practice,” in Proc. of the 37th Int’l Conf. on Software Engineering (ICSE’15) –Volume 2, pp. 497–500. IEEE CS, 2015.

URL <http://dx.doi.org/10.1109/ICSE.2015.182>

Enterprise models are typically used as a means of establishing a shared understanding of an enterprise. More recently they are increasingly seen as having potential for controlling the enterprise especially through improved decision making capability.

Research has typically focussed on developing languages, tools and methodologies to help in the production of enterprise models. Social contexts or individual factors have largely been neglected as they have not been easy to represent in model form.

This presentation will focus on a reflection on the sociology of the organisation in order to outline routes to build theories of how social contexts and individual factors can be usefully analysed for the purposes of enterprise modelling. An example of modelling (moral) values will be used to illustrate the core characteristics of such an approach. This approach is derived from research completed on the development of mobile application for youth offending teams in the UK and reported in ICSE 2015.

3.2 Using Meta-Modelling to Integrate Languages for the Model Driven Organisation

Tony Clark (Sheffield Hallam University, GB)

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An organisation consists of many different systems embedded in chains of usage that involve a mixture of human interaction and computer-based interaction. Interaction involves languages either to initiate computation or to communicate between systems, and between humans and systems. In virtually all current systems that underpin organisations the languages are fixed and are provided in some way by a third party – often system vendor. This leads to languages that are not particularly domain specific, do not take into account the level of IT sophistication of the user, and that are brittle because they cannot be changed without significant modification to the underlying systems.


Recent years has seen a trend in implementation technologies, particularly programming languages, that has provided meta-access to the underlying data representation and computational mechanisms. This allows run-time systems to analyse their own behaviour and make limited modifications to it. The motivation for such developments is to improve the resilience of large-scale systems in light of changes that are beyond the control of individual components. However, these improvements are limited and not particularly co-ordinated.

Organisational agility can be significantly improved by using meta-based approaches to the design and implementation of the organisation. This will lead to much better data and language integration, better resilience and an ability to tailor the languages used to interact with parts of an organisation. An organisation can become adaptive by reasoning about its

own behaviour and each stakeholder can tailor the interaction language to suit their role and level of technology awareness. Having a meta-model of the underlying data structures supports an integration of otherwise disparate data types since the semantics of data is incorporated into the system itself.

3.3 An Industrial Perspective from SAP

Elmar Dorner (SAP SE – Karlsruhe, DE)

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I'm for more than 15 years with SAP, working in different roles, but always as a Researcher. Throughout that time, the “Research” organization/department changed in several ways. The underlying working model, vision and mission got changed or updated based on internal and external influences. This included the scope of the work, as well as the interaction/engagement model. Also the operational model changed: More systems/tools for collaboration were introduced, processes for information handling were established, and a project management was put in place.

It's an open questions if these changes, especially of the working model of the organization, were established and implemented to advance operational efficiency and agility.

3.4 Organisational Perspectives: Elephants and Bazaars

Peter Fettke (DFKI – Saarbrücken, DE)

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In my talk, I introduce two well-known metaphors for modelling and making information systems. According to the metaphor “The Blind Men and The Elephant”, models of an organisation can be very different, although they represent the same object. More perspectives on an organisation give a richer picture of its characteristics. The usefulness of one model depends on the perspective of the modeller on the organisation.

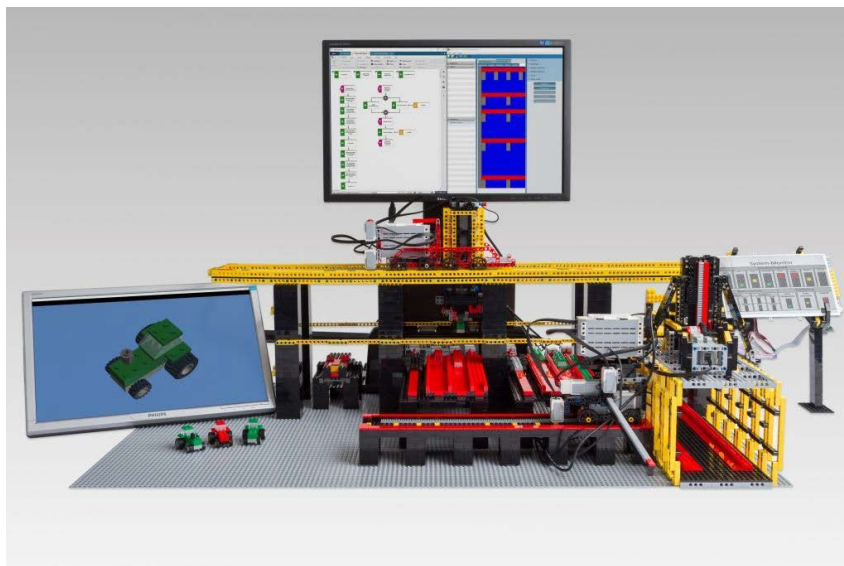
The second metaphor “The Cathedral and the Bazaar” offers two ideal stereotypes for making information systems, which can be characterized by several concept pairs depicted in Table 1. Understanding an organisation more like a bazaar makes it more agile and adaptable to a changing environment.

The recent development towards Industry 4.0 exemplifies how an agile manufacturing organization might look like. In my talk, I present a Smart Factory demonstrator built with Lego® bricks (Figure 1). This prototype illustrates how principles of Industry 4.0 can be implemented.

I close my talk with potentials of Big Data Analytics, which provide a new, computational perspective on an organizational bazaar. Based on the Lego® Demonstrator, I point out prospects of large scale data sets for the inductive creating of models and decision making.

■ **Table 1** The Cathedral and the Bazaar – Some Characteristics.

Cathedral	Bazaar
unity	plurality
standardisation	individualisation
one model	many models
monolithic	modular
mono-perspective	multi-perspective
top-down	bottom-up
deduction	induction
hierarchical structure	network structure, partially chaotic
fully integrated	only partially integrated
consistent and coherent	partially inconsistent and incoherent
error free	with errors
central organisation	self-organisation



■ **Figure 1** Industry 4.0 implemented with Lego® bricks.

3.5 Models as a Means for Supporting Digital Enterprises

Hans-Georg Fill (Universität Wien, AT)

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In my talk I focus on the role of models for representing and analyzing enterprises in a digital economy. In my view, the main function of models is thereby the reduction of complexity through abstraction. In this way, models not only contribute to easing the communication between different human actors in an enterprise. They also establish the basis for the algorithmic processing of enterprise information. For illustrating this aspect I present recent research results on joining enterprise models for representing knowledge with enterprise models for representing and configuring data analyses. A particular focus of future research on these topics will be the gradual evolvement of enterprise modeling methods to continuously

adapt to upcoming requirements. In this context, I will briefly outline the SeMFIS approach for the semantic annotation of conceptual models that has been developed throughout the past years. It permits the extension of the semantic representation and analysis scope of modeling methods without changing the original modeling language. Thereby, the consistency of existing modeling methods and models created with them is preserved, while at the same time new information requirements can be satisfied. Such approaches are considered to be essential for digital enterprises where new business and technological requirements constantly emerge and need to be reflected in the corresponding models.

3.6 The Role of Models and Language

Ulrich Frank (Universität Duisburg-Essen, DE)

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More than ever, models are of pivotal relevance for enterprises to plan and run their operations and to collaborate in cross-organizational settings. This is for various reasons. First, the traditional “brick and mortar” type of companies is more and more replaced by companies that do not offer any physical presence to their customers. Therefore, it is essential to provide some kind of model of the company to give external stakeholders an idea of who they are dealing with. Second, an ever increasing amount of work in organizations is supported by software or even entirely automated. Due to the immaterial nature of software, it is mandatory that employees have a model of software that enables them to use it and, at best, to understand how it operates and how it may be adapted to new requirements. Third, the increasing demand for establishing cross-organizational work patterns, such as business processes and projects, required to integrate the relevant parts of information systems. Integration implies the existence and representation of commonalities, which in turn need to be represented in some kind of model that is accessible by all involved parties. Forth, the increasing complexity of products and services demands for specialization, that is, for different professional perspectives on an enterprise. At the same time, specialization creates the challenge of coordinating people with different viewpoints and heterogeneous objectives. Models may support particular perspectives with elaborate professional concepts. At the same time, multi-perspective enterprise models are suited to foster coordination through the integration of specific models of an enterprise. Last, but not least, most companies need to cope with the challenges of the digital transformation. In many cases, that will require them to change quickly without too much risk. For this purpose, they need to imagine future models of the enterprise to think and evaluate possible paths of change.

From an academic perspective, the need for models creates fascinating research opportunities. Conceptual models are linguistic artefacts. They are constructed with modelling languages, and their interpretation requires references to natural language. Domain-specific modelling languages (DSMLs) represent a promising approach to make the design and use of models more convenient and more consistent. However, the specification of DSMLs is confronted with considerable challenges. First, there is a principal conflict between economies of scale and productivity of reuse. Economies of scale recommends the development of DSMLs that can be used in a wide range of cases. However, more specific DSMLs promise a higher level of productivity in those cases where they fit. Second, it would empower users and contribute to the adaptability of software systems to supplement them with corresponding

conceptual models. However, these models are useful in the long run only, if they evolve synchronously with the software systems they represent. Today's programming language architectures require separate representations of models and code, which results in the notorious synchronisation problem. Therefore, language architectures that enable a common representation of models and code would be extremely useful. Finally, the need for change creates a special challenge. The world we live in, the work practices and services, we are used to, get their meaning through the language we speak. It is our primary tool of thought. However, if companies are to change, the concepts we are used to, are likely to limit our imagination. Therefore, research needs to aim at ways to relax these limitations. Such an objective is extremely challenging and there is no deterministic procedure to accomplish it. However, it corresponds to the old idea of theory development, namely to "outlook" for new ideas that go beyond the obvious – through abstraction. A new paradigm of conceptual modelling that is based on multilevel language architectures seems to be well suited to address the challenges related to the construction and use of DSMLs. It also allows for a common representation of models and code, which enables the construction of a new kind of software systems that are integrated with conceptual models of their own and the surroundings they operate in.

3.7 Using Work Agreements as Operation-time System Requirements for Emergent Work Community Support Systems

Stijn Hoppenbrouwers (HAN University of Applied Science – Arnhem, NL)

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We propose an approach for capturing evolving requirements for work support systems that are organically created by co-workers in self-organized, networked organizations. It is in the nature of such organisations that comprehensive design-time capturing of the volatile task-related functional requirements is not possible. Therefore, we advocate a combination of two types of requirements: i. stable requirement fragments elicited at design time, based on elementary collaboration and communication patterns likely to occur in an operational context, and ii. highly dynamic requirements in the form of explicit, easy-to-understand yet well-structured work agreements between organisational actors within organisations at operation-time. These agreements capture many aspects and concepts well known from requirements engineering, as well as business process analysis and design, but design-time modeling/specification of work-specific structures is now moved to operation time. Description of such structures by co-workers is supported by mechanisms part of the stable communication patterns under i.

3.8 Model-enabled Organizations

John Krogstie (NTNU – Trondheim, NO)

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Whereas it has become usual in the community to talk about model-driven organizations (inspired by the use of the term data-driven), I have in the talk taken a more human-centric

approach calling it ‘model-enabled organizations’. Models can to a much larger extent be used to enable organizational behaviour. Thus of the many topics suggested for the seminar, we have focused on the questions related to modeling, i.e.

- What kind of models of organizations do you find useful for what purpose?
- Who are/should be primary addressees of such models?
- What do you relate to the idea of models being repositories of organizational knowledge?
- Should modelling languages (DSMLs) rather aim at fitting a wide range of organisations or should they be tuned to the specific needs of one organization?

In particular it is looked upon how to achieve the long-term value of models, by understanding the different goals of modeling (and how to align short and long-term goals), and looking upon models, modeling languages, modeling methods and modeling tools and how stakeholder knowledge of all these areas have to be included and utilized. An example of large-scale modeling of the quality system in an oil company is presented, and even if it can be looked upon as a successful case of a model-enabled organization, also a number of challenges and possibilities for improvement are identified. To address these, we in particular look upon how interactive models can be used to support bottom-up (grass-root) modeling in combination with the traditional top-down modeling of the quality system/enterprise architecture.

3.9 MDO: Key requirements from industry perspective

Vinay Kulkarni (Tata Consultancy Services – Pune, IN)

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Joint work of Vinay Kulkarni, Souvik Barat, Tony Clark and Balbir Barn
Main reference V. Kulkarni, S. Barat, T. Clark, B. Barn, “Toward overcoming accidental complexity in organisational decision-making,” in Proc. of the 2015 ACM/IEEE 18th Int’l Conf. on Model Driven Engineering Languages and Systems (MODELS’15), pp. 368-377, IEEE, 2015.
URL <http://dx.doi.org/10.1109/MODELS.2015.7338268>

Modern enterprises need to respond to a variety of change drivers in order to stay competitive in rapidly changing business context. The cost of erroneous decision is often prohibitively high and there may not be an opportunity for course correction later. Minimizing such undesired consequences calls for a-priori judicious evaluation of the available courses of action as regards their influence on the desired objective. The decision-makers are thus expected to understand, analyze and correlate existing information about various aspects of enterprise such as goals, operational processes, change drivers and their influence etc. Large size, complex structure, inherent socio-technical nature, and multiple stakeholders with possibly conflicting goals all contribute to the complexity of organisational decision-making. Increasingly felt demands of agility and certainty make this endeavor even more challenging. Current industry practice relies mostly on human experts with spreadsheet, word processors, and diagram editors being the most popular tools used for capturing the relevant information about enterprise. Informal nature of this information means power, rigour, and speed of sophisticated analysis cannot be brought to bear upon the decision-making problem. As a result, quality of the solution is largely dependent on knowledge and experience of human experts involved in the decision-making process. As modern enterprise is a large and complex system, the sheer volume of information makes manual analysis ineffective as well as inefficient. Moreover, as modern enterprise operates in increasingly dynamic environment, the information required for analysis needs to be kept up-to-date at increasingly rapid rate

thus making manual analysis further untenable. Also, the required information is typically strewn across multiple documents, spreadsheets and pictures. Stitching together a coherent, consistent and integrated view from these pieces, and keeping it up-to-date over time is a serious challenge. All these factors contribute to the present lack of agility and uncertainty in organisational decision-making. Therefore, there is a need for an approach to organisational decision-making that enables decomposition of the overall goal into sub-goals, sub-sub-goals etc to the desired level of granularity. It should help identify a set of variables (i.e. Measures) that need to be observed in order to determine whether the finest-level goal is met. It should also help identify a set of variables (i.e. Levers) that influence a given Measure and be able to specify the influence in a formal manner. It should enable make explicit the dependencies between levers, between measures and between goals. This goal-measure-lever graph structure helps capture the understanding of problem domain in a manner that is amenable to automation. Decision-making then is a bottom-up walk of this graph structure provided it is possible: (i) to compute values for the measures based on the values of levers, (ii) to evaluate whether a goal is met based on the values of measures, and (iii) to honour lever-to-lever, measure-to-measure and goal-to-goal dependencies in the bottom-up walk. Therefore, organisational decision-making can be viewed as human-guided exploration of design space wherein past experience and expertise get captured in knowledge form.

3.10 There is Relevant Information in Models, but Models are not Really Relevant – Why?

Andreas Leue (Sphenon GmbH – Hamburg, DE)

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
Based on the experience of applying and observing model driven technologies to software production and related business management and organisation tasks for over 25 years, the speech tries to give an answer to the stated question.

First, some examples of working and useful (“good”) models are presented, following by some counterexamples. Then, the majority of the slides discuss a variety of observed reasons: 1st, in the past insufficient tools ignited a downward spiral of model misuse and bad model reputation, 2nd, the enormous speed of technology and paradigm changes combined with far too many people working under high project pressure with too few skills to work with sophisticated technology prevents the maturing of everything which does not promise shortterm wins, 3rd, unintentional misuse of models like the application of token/controlflow based process schemas originating from a technical system domain to the business coordination domain, 4th, intentional misuse and rejection of model driven technology due to hidden stakeholder interests, like counteracting transparency, 5th, the utterly complex phenomenon of agility with a certain amount of positiv as well as a certain amount of negative impacts on model applicability, partially on justified and partially un unjustified ground, and 6th, the highly complex business landscape environment in which models have to survive, which needs to be approached from different system category perspectives like biological, linguistic, social, and economical in addition to the purely mechanical view related to IT.

The speech nevertheless finally presents an optimistic view of a future modelling biotope, in which small model parts coexist more loosely while at the same time more tightly bound, and with more loose semantics while at the same time more precise ones, and more interconnected while at the same time more isolated in a worldwide modelling artefact web.

3.11 Supporting Organizational Efficiency and Agility through Model-Based Collaboration Environments

Florian Matthes (TU München, DE)

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Since 2002, our chair at the Technische Universität München investigates collaborative modeling activities in organizations of different types:

- Agile Enterprise Architecture Management in DAX and MDAX **enterprises**
- Collaborative modeling and incubation processes for digital **startups** and spin-offs (E-Commerce, Fin Tech, Legal Tech and E-Mobility)
- Eco-system modeling and management of **networked organizations**
- Modeling **legal aspects** in all of these organizations and networks.

For the purpose of this research, we have developed and applied a series of model-based collaboration environments since 1999 that have been expanded and simplified based on our improved understanding of how people actually use IT **tools to think, work and learn together** in organizations.

Model-based collaboration environments (MBCEs) provide the means for empowering information carriers and modelers to collaboratively and incrementally develop, maintain, and evolve models in a bottom-up fashion by using a light-weight **Hybrid Wiki approach** [3]. This approach enables the **emergent enrichment of unstructured content with structure**, achieving a MBCE that supports the co-evolution of organizational models (agents, roles, permissions, responsibilities, work plans, tasks, . . .) and the underlying rich linked data models and computations in a coherent and consistent manner [4, 5].

Hybrid Wiki workspaces can be used for knowledge-intensive work at the **personal, group and enterprise level**. This allows for different adoption strategies in organizations of different complexity.

The Hybrid Wiki approach combines both modelling approaches, namely **top-down modelling** (models-first) and **bottom-up modeling** (data-first). Its goal is to empower organizational stakeholders, including modelers and non-modeling experts, to collaboratively gather and consolidate information in a flexible meta-model-based information system (**SocioCortex**, www.sociocortex.com), which acts as a MBCE for members of the organization [5].

The **backend of the platform** has a layered architecture based on a flexible temporal database for semi-structured linked content, with higher layers implementing dynamic content models, discretionary and role-based access control models, typed queries and functions, and artefact-centric process models.

The backend functionality is made accessible via open REST-based APIs and a typed query language to **generic (reflective) web clients** for collaborative content, task and model management and to **problem-specific front-end applications** (web clients, rich clients, mobile clients, embedded clients in other tools) and other information management and identity management systems (via a so-called Sync Pipes).

Research projects and university spin-offs have successfully used our MBCEs to support collaborative work in organizations of very different sizes, in different business domains, and also in organization networks.

For example SocioCortex can be utilized for modeling governance processes by the use of role models and associated concepts [1]. Furthermore, it provides an interactive web

user-interface that assists users and modelers in writing queries, views, constraint and KPI definitions in a domain-specific expression language [6] based a polymorphic type system over rich linked data models. In the field of adaptive case management, it provides knowledge intensive process models for supporting the collaborative structuring of processes for knowledge works [2]. Last but not least, it supports the versioning of goal models and the calculation of KPIs for determining goal satisfactions of an enterprise model [4].

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3.12 Enterprise Modelling and Semantic Technologies

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Big and open data will continue to grow in importance in the future. Semantic support will be needed to manage, manouever and make sense of the vast amounts of big open data available on the web. Standards and technologies for such semantic support have already been developed through efforts such as the semantic web, the web of data and linked open data. Although semantics is a key competence of the enterprise / IS / conceptual modelling community, there have been few attempts to bridge from enterprise modelling over into big, open and semantic data so far.

One potential bridge is that semantic data sets are annotated using standard terms defined in vocabularies, some of which (such as Prov and Org) already resemble enterprise modelling languages. Another potential bridge is to mine EM modelling languages and models from big semantic data sets and to use the resulting languages and models to navigate and make sense of the big data. A third bridge is to enrich enterprise models with open semantic data. A fourth bridge is to make enterprise models available as part of the semantic web / web of data / linked open data.

In the future, these and other bridges between enterprise / IS / conceptual modelling and semantic technologies can be leveraged to make enterprise and other models more autonomous and adaptive. Such “smart models” can live behind firewalls or in the cloud and will comprise semantically annotated models supported by clusters of reusable software agents. The smart models will support future agile organisations through their ability to, e.g., dynamically update and enrich themselves, make links to and exchange information with other smart models, initiate and monitor organisational events and processes, reason about their purpose and possible uses, and offer themselves in suitable formats to new prospective human and machine users.

3.13 Beyond Agile Organizations

Dirk Riehle (Universität Erlangen-Nürnberg, DE)

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Software development organizations are organizations that have led the move to “agile” first for software development itself, later across the whole enterprise, including all other business functions. However, agile software development has its own shortcomings and also has not succeeded in breaking down barriers to collaboration across organizational silos. Inner source, the use of open source collaboration practices within the organization has emerged as the next step in organizational change, in which employees are empowered to complement traditional management practices with bottom-up intelligence and cross-silo collaboration. In this talk, I report about 10 years of work on inner source software development and speculate how it might transcend software development and extend to the whole enterprise.

3.14 A Perspective on Organisational Efficiency and Agility

Kurt Sandkuhl (Universität Rostock, DE)

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In general terms, enterprise modeling addresses the systematic analysis and modelling of processes, organization structures, products structures, IT-systems or any other perspective relevant for the modelling purpose. Enterprise models, as well as models of software systems and services, can form an important contribution to improving organizational efficiency and agility. Among the driving forces of competitiveness are – from our perspective – the capability of enterprise to quickly adapt to (context) changes which cannot be anticipated and an understanding of dependencies and relationships between organizational perspectives. Thus, we consider the following kinds of models in particular useful to support agility:


- Models capturing the (deployment) context of enterprise services and product, i.e., models of deployment context and models of actual business service or product should be separated
- Models of business models
- Enterprise Architecture models, in particular with focus on effects of digitization (including cyberphysical systems, Internet-of-Things, . . .)

Addressees of such models are not limited to IT experts and technical people, but a wide participation of enterprise stakeholders is required in development and use of models, e.g. for business and IT alignment.

As subject for future work, we propose to investigate “liquid models” which are flexible, dynamic and quickly adaptive regarding all possible aspects and perspectives of the model, e.g., model content, meta-model, model usage, model users, model boundaries, model creation. Such “liquidity” would support other model use scenarios required for improved support of agility, e.g., from models as design time artefact to runtime artefact or models which emerge in collaboration between what happens in reality and what is designed by stakeholders in the enterprise.

3.15 Towards Enterprise Architecture Modelling Practices

Gerhard Schwabe (Universität Zürich, CH)

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My research background is CSCW/Collaborative technologies, Collaboration Engineering and IT Management. I have never published on Enterprise Architecture. However, I came into contact Enterprise Architecture Modelling practices in two projects: In a large project with a large Swiss Bank I studied the renovation of the core banking platform in 2004. And from 2011-2015 we studied the innovation practices at a large independent Swiss software vendor. In both organizations the use of formal Enterprise modelling was very limited; they rather relied on informal description applying Powerpoint. I therefore call for more studying and supporting actual architectural practices. Here lightweight tools relying on visual understanding and aesthetics become important.

3.16 A Few Thoughts on the Notion of ‘Model Driven Organisation’

Stefan Strecker (FernUniversität in Hagen, DE)

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In my talk, I question the notion of ‘engineering an organization’ by contrasting the formal structures, formal rules, and formal communication of/in an organization and by pointing to the importance of informal norms, communication, roles, groups, and leaders, among others. A ‘functionalist’ view on what drives organizations is contrasted by – one among many – complementary views I call the ‘anthropological’ view. The ‘functionalist’ view focusses e.g. on planning, decision-making, incentivizing, executing, controlling, monitoring, and auditing whereas the ‘anthropological’ view reminds us of important aspects of organizing, e.g., power games, symbolic action, hidden agendas, opportunistic action, untruthful revelation of intentions, implicit assumptions (see, e.g., Weick, Morgan, Mintzberg). The main theses of my talk is that ‘organization members’ strive for understanding and (ex post) rationalisation and attempt to ‘make sense’ of their perception of their ‘organizational reality’ which results in the implication that communication is both an essential foundation and a barrier at the same time. This leads me to the function of conceptual models which I believe we need to link to a moderate ambition, i.e., contribute to a bit more reason (+ rationality) through substantiated

communication: Conceptual models enable communication about non-tangible aspects of organising, contribute to overcome communication barriers, foster a shared terminology and understanding of organising, and, hence, contribute to ‘sensemaking’ in organizations. We may then advance our ambition by reconstructing (i.e. reshaping) existing (technical) language taking information technology and the limits of language (design) into account. At the end of my talk, I mention questions I like to discuss in this Dagstuhl seminar.

3.17 Views of an Outsider

Reinhard Wilhelm (Universität des Saarlandes – Saarbrücken, DE)

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My background is in verification, in particular of safety-critical embedded systems. Model-based design is the dominating development method in this domain. Systems are modeled on an appropriate level of abstraction, incorporating concepts such as feedback loops, filters, finite state machines. Code is automatically generated from the specification of a model.

It is tempting to repeat this success story in the area of business information systems. However, there are several problems. The appropriate level of abstraction has not been identified, yet. At least this did not show up in the presentations at the seminar, and in most of the systems, the human is in the loop, and the human is impossible to model. One could still attempt to model the other system components and offer the human actor a choice of alternatives together with an estimation of their costs, their benefits and other attributes.

3.18 Architectural Thinking

Robert Winter (Universität St. Gallen, CH)

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In the context of the ongoing digitalization, models and modelling could gain significance if they enable

- gaining and maintaining deep insights about (internal & external) customers, e.g. their valuation of offerings,
- quick re-configuration of front stage IS and integration with efficiently run back stage IS,
- co-creation, i.e. the evolution of service providers from a vendor into an integral component of the customer’s value creation, and
- flexible re-configuration of value-creation networks.

Is the current enterprise modelling discipline capable for such enablement? Only partially, because the community is often driven “inside-out”, i.e. proposing models and modelling approaches based on perceived requirements without sufficiently understanding who is actually needing which kind of models for which kind of purposes. As a consequence, modelling and models have not reached their maximum possible impact in organizations, and are often only used by too few people for too few purposes. The enterprise modelling discipline needs to cope with very diverse concerns and stakeholders, leading to new requirements for models / modelling at different speeds and at different levels of precision. A complementary approach has been proposed under the label “Architectural Thinking”. It intends to understand and reach “the other 90% of the organization” (who are not architects or IT people).

3.19 The Demand for a Customer Owned Ontology Model Layer in Continuous Enterprise Engineering at Cloud Computing

Peter Zencke (Universität Würzburg, DE)

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Cloud Computing and Software as a Service is a disruptive technology with the potential to fully transform the ICT industry. While cloud computing with the operational efficiency of mega datacenter makes the usage of enterprise systems affordable for small and midsize enterprises and eliminates the cost of many traditional IT related services, the business adaptability of SaaS solutions is still at an infant stage. Most SaaS solutions treat all their tenants as equal allowing very limited customization.

In a business environment where enterprises have to strive for competitive differentiation, this limitation of today's cloud computing can hinder the broad adoption of enterprise SaaS. Enterprise Cloud Computing demands for a dedicated architecture to enable customer specific continuous engineering for change and adaptation.

In Enterprise System Engineering the separation of concern of different modeling views is state of the art. The three most important enterprise model views are datalogical, infological and ontological models. For cloud enterprise solutions in addition these three views have to become independent model layers with clear separated ownership.

At Cloud Computing the datalogical layer will be a shared layer for all enterprise tenants using the same Big Data infrastructure of non relational high performance data services. The infological layer at cloud computing will consume the data services of the datalogical model eliminating the redundancy of separate transactional and analytical data storages. Infological model views are computed at run time driven by an active infological repository with customer specific content.

The ontological model representing the enterprise organizational structure with its activities and processes by nature has to be in full ownership of each cloud tenant. Ontological models become a necessary layer in SaaS enterprise solutions allowing for competitive differentiation of enterprises in the cloud in a constantly changing business environment. Enterprise Engineering in the cloud must model the customer specific enterprise ontologies against generic services of Enterprise SaaS/SOA Platforms. By that Continuous Enterprise Engineering will become a crucial architectural pillar for future Enterprise Cloud Solutions.

4 Working groups

4.1 How to Deal with Organisational Evolution

Balbir Barn (Middlesex University – London, GB), Gregor Engels (Universität Paderborn, DE), Peter Fettke (DFKI – Saarbrücken, DE), Andreas Leue (Sphenon GmbH – Hamburg, DE), and Peter Zencke (Universität Würzburg, DE)

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This group addressed the issue of how to acquire, evolve and assess a model for an enterprise under change.

For the purposes of the discussions the group defined an enterprise as having a structure including business units and business partners, and a communication structure. It has business goals and value creating processes. An organisational model can be acquired using inductive machine learning, crowd sourcing, modification of a reference model. There is a difference between a top-down approach vs. a bottom-up approach to model generation. Top-down can be developed from reference models and the known communication structure of the organisation. Bottom up can be mined from information sources such as email systems, ERP systems, workflow systems etc. Mining techniques can include machine learning, ontology learning.

When reasoning about evolution, it is important to understand the root causes and reasons for the change and to identify any patterns of change. It should be noted that not all information on work system of an enterprise is captured by the process model relationship between enterprise model and the used IT systems (EAM) is to be discussed in more detail

The group investigated 3 case studies: a startup; an established company without an existing enterprise model; an established company with an enterprise model entering a new market.

The group identified the following open questions:

- Current enterprise models do not capture reasons for change; future system should capture such information more competence in machine learning (feasibility), how to identify learning/training sets of data? Which techniques can be used / are appropriate? Nature-language processing / text mining, ontology engineering,
- There is work in the area of text mining in social media (facebook, twitter etc.). But this work is not connected to enterprise models
- How the content should be modelled that all parts of the organisation have benefit of the enterprise model?
- What is the correct level of abstraction of enterprise models to be useful? Particular views are typically stakeholder specific.
- Are there interesting meta-data for enterprise model which allows us to infer learning about the organisations, e.g. meta-data about the telecommunication tells us something about the individuals?
- Which language for which stakeholder for which element of an enterprise model is adequate?
- Which machine learning techniques can be useful for deriving enterprise model from existing data sources?
- Dealing with complexity and heterogeneity of data

Possible important research approaches include: Design science; Identification of important use cases (e.g. Mergers & Acquisition may be one interesting example); collective intelligence, crowd innovation.

The group identified the following open discussion questions:

- notion of theory, is always a theory needed
- principle problem of induction, how do you know that your inductive reasoning is valid/interesting
- interesting use case: compliance checking, you already have a model and check whether the data fits to model

4.2 Ambiguity Aware Models

Tony Clark (Sheffield Hallam University, GB), Jan L. G. Dietz (TU Delft, NL), Ulrich Frank (Universität Duisburg-Essen, DE), and Henderik Proper (Luxembourg Inst. of Science & Technology, LU)

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This group discussed how to address the scale and complexity of organisational modelling through the use of ambiguity. Ambiguity means:

1. Underspecification (for example price:Float) leading to a broader than intended range of possible values.
2. Under-defined semantics (for example business process modelling languages). Leads to modelling languages being used for a wide-variety of purposes. There is a relationship between ambiguous models and formality.

It is the ability to be precise about the level of open-ness in a model in order for the development process to be able to start with something that is under-defined and end up with something that is good-enough and to support different approaches to modelling e.g., depth-first and breadth-first.

Ambiguity can be achieved by:

1. Leave parts of a model open in a controlled way. These can be made more strict when used.
2. Use specialisation as defined in types (equivalently set-theory) or in Object-Orientation.
3. Perhaps use meta-information associated with parts of model, use different displays for those parts of a model that are more or less specific. For example different shapes, softer-edges, different fonts.

4.3 Theories for Organisations

Jan L. G. Dietz (TU Delft, NL), Ulrich Frank (Universität Duisburg-Essen, DE), Henderik Proper (Luxembourg Inst. of Science & Technology, LU), and Stefan Strecker (FernUniversität in Hagen, DE)

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There is no widely accepted theory for an Organisation that is amenable to computational processing in order to achieve organisational agility. The CIAO paradigm of J. L. G. Dietz is one possible contender. It should be possible to learn from existing theories based not the work of Max Weber, Gareth Morgan, Weick, Habermas, Luhmann, Enid Mumford, Peter Drucker, Peter Senge, Henry Mintzberg etc. where there are many different approaches including reductionist view, functional view, contingency approach, Stijn's Metaphor of 'software as frozen language' etc. We should investigate the work that addresses the intersection of organisational research, information systems research and software engineering.

Perception of organizational realities differs among observers (and we do not to subscribe to a social constructivists stance for that). The CIAO EE approach is based on the notion of 'I see what there is in organizational reality' and can validate what I see by talking to people. Modelling language enable simulations and provide a value to the org. research community Set of lenses – it is your choice to choose and apply a lens – might lead to inconsistencies. Can an organisation be engineered: this depends on notion of 'engineering' and 'organisation' for giving a positive answer to the question requires a specific understanding of both terms.

4.4 Business Modelling and Value Creation Modelling

Hans-Georg Fill (Universität Wien, AT), Stijn Hoppenbrouwers (HAN University of Applied Science – Arnhem, NL), Florian Matthes (TU München, DE), Henderik Proper (Luxembourg Inst. of Science & Technology, LU), Gerhard Schwabe (Universität Zürich, CH), Stefan Strecker (FernUniversität in Hagen, DE), and Robert Winter (Universität St. Gallen, CH)

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This group addresses the issues relating to the creation of business models including value creation.

The context for the discussions included the shift from increasing efficiency of established organizations (with a working business model) to development of innovative (digital) business models where the value perception of customers is of top priority. Startups, spinoffs, new products often fail because of non-existing customer adoption and not of lack of technical feasibility. There is a shift from deployment to use and a shift from organization-centric structures to customer-centric value networks, for example: multiple independent mobility providers versus focus on mobility need of single a customer

Value modelling is an important consideration for achieving organisational agility because: there is an imperative to deliver solutions that are desired, feasible and viable. There is an increasing need to broaden the perspective of design to include customer value. It was noted that “Desirability” aspects needs better understanding and that the modelling community has a part to play in achieving this.

We want to enable a computer-supported processing of value models. The challenges for the modelling community include:

1. Difficulty of adequately capture the notion of value (what is value).
2. Difficulty to adequately represent / approximate and process value (creation, aggregation, comparison, propagation)
3. Difficulty to clarify the context in which “value” is used, for example: Potential value vs Realized value

A value is a multi-dimensional concept that includes more than money (financial value) for example, esthetic value, well-being, political value, ethical value, intellectual capital. Dimensions include:

- Aggregation level (individual, group, organization, networks of organizations, society)
- Type of valuation (monetary, esthetic, ...)
- Object to be valued (product, service, functionality, solution, process, brand, ...)
- Ability to support automation (none, qualification, quantification, calculation / reasoning). Calculation and reasoning can be further distinguished into:
 - Formalized (algorithmic) reasoning
 - Argumentation and negotiation where human arguments can be based on intuition
- Static (pre-determined, in a design, build, run, observe cycle) or Dynamic (at runtime in a short-term control loop, e.g. auction process)

How to represent / approximate and process value What coverage of value was – and is now – possible?

- At design time: (that has always been possible):
 - Clarify – support stakeholder discourse regarding value proposition (pre system)
 - Facilitate – represent value in design (IS design tool passive),
 - Engage – semantic representation of value (IS design tool active)

- At use time: (that comes with digitalization)
 - Observe – capture value realization
 - Act – adapt IS to use and context

Difficulty of “aggregating” value (logic / arithmetic) because of the need of a context:

- See also examples below
- How to approximate the value perceived by a subject?
- How to model short-term and long-term value?

Example 1: Dynamic pricing of airline fares (B2C)

- Aggregation level: individual
- Type of valuation:
 - value indication: monetary
 - value approximation : binary (accept/decline)
- Object to be valued: service (bundle?)
- Ability to support automation: Formalized (algorithmic) reasoning and could be improved
- Dynamic (at runtime in a short-term control loop)

Example 2: Design of a value network – Moovel (B2B)

- Aggregation level: value network
- Type of valuation:
 - Long-term strategic value
 - Degree of flexibility(buy,jointventure,long-termcontract,ad-hocinteraction)
 - Stability
 - Complementarity from the customer perspective
 - Monetary value
 - Brand value(Lada,Mercedes)
- Object to be valued:
 - mobility-related business capabilities
 - * share a car, call a taxi, rent a bike, find a parking spot
 - * rate the quality of a service
 - * route planning
 - * dynamic pricing
 - * payment
 - organizations(Daimler,BMW,DeutscheBahn,Sixt,Moovel,Google,...)
 - * competitor analysis
 - * value exchanges
 - Ability to support automation:
 - * Clarify-supportstakeholderdiscourseregardingvalueproposition
 - * Lots of room for improvement
 - Static (contract design between organizations, joint ventures, cooperatives, mergers and acquisitions)

Example 3: Health wristband deployment within an organization (informal negotiation inside the Org.)

- Aggregation level: organization
- Type of valuation: Privacy, well-being, occupational health, monetary value
- Object to be valued: solution functionalities
- Ability to support automation:
 - Clarify – support stakeholder discourse regarding value proposition (tensions, negotiations, incentives)

- Lots of room for improvement
- Static (Betriebsvereinbarung, works council agreement)

Example 4: Application landscape evolution within a given IT governance structure (conflicts raised by different planning horizons, scopes and goals inside the organization)

- Aggregation level: organization
- Type of valuation: completeness of requirements coverage, business complexity, architectural debt, time to market, compliance, security, sustainability. Value approximation: sets of incremental service improvements
- Object to be valued: IT service portfolio
- Ability to support automation: depending on maturity qualification, quantification, for selected value dimensions even reasoning (simulation) Limits of reasoning in particular in the “desirability” space
- Static (pre-determined, in a design, build, run, observe cycle)

Reflection

Value seems to be a fundamental concept that needs to be better understood to approach a wide array of design problems. In our discussion we observed that the existing approaches to represent and process value take a discrete approach (instance, class, metaclass). It might be useful to investigate multi-dimensional continuous or subsymbolic representations and reasoning (neural networks). Analogy: Rule-based knowledge management systems vs. statistical machine learning approaches Analogy: Relational Database Systems vs. Information Retrieval Systems

4.5 Run-Time Models in Enterprises

Ulrich Frank (Universität Duisburg-Essen, DE), Jan L. G. Dietz (TU Delft, NL), Henderik Proper (Luxembourg Inst. of Science & Technology, LU), Dirk Riehle (Universität Erlangen-Nürnberg, DE), and Kurt Sandkuhl (Universität Rostock, DE)

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This group discussed the issue of using models at run-time to support enterprise agility and to react to unanticipated events. The notion of *Liquid Models* was discussed where liquidity includes adaptability + scalability + usability

- Adaptability: concerns changes in the organization and in the context of the organization; model can be changed by stakeholders in the organization or by events in the organization or its context.
- Scalability: concerns the scale and complexity visible in the model; model content and boundaries affected.
- Usability: fully adaptable and scalable models still have to offer value and utility to stakeholders.

A vision for models at run-time: Stakeholder specific models explicitly available (for interaction to understand current systems and have a way to update (parts of) the system support) empowering users. Stakeholder specific visualizations(model-views) and should not be a need for intermediate format(as in traditional code-generation).

Models should be integrated with the enterprise software. There should be no discernible impedance mismatch between changes to the model of (an aspect of) the organisation and changing part of the enterprise software from the perspective of the stakeholder. In this context model should be interpreted as meaning: a stakeholder-specific perspective of the system. The environment should be included in the definition of 'enterprise software' and the model. The result of this integration is a seamless stakeholder perspective of the organisation and its context as a model.

4.6 Practice of and Collaboration for Creating and Using Models

Stijn Hoppenbrouwers (HAN University of Applied Science – Arnhem, NL), Hans-Georg Fill (Universität Wien, AT), Andreas Leue (Sphenon GmbH – Hamburg, DE), Florian Matthes (TU München, DE), Andreas L. Opdahl (University of Bergen, NO), Kurt Sandkuhl (Universität Rostock, DE), Gerhard Schwabe (Universität Zürich, CH), and Robert Winter (Universität St. Gallen, CH)

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This group discussed the issue of using models in organisations – *why bother?*.

In order to further analyze the problem and develop the vision, several dimensions should be investigated, including Who is creating models? grassroot (i.e. everybody in an enterprise), traditional (modeling experts lead the process), machine-generated (e.g. from enterprise information sources), integration of existing models. Model representations and formalisation. Model scope and users: individuals, group, enterprise, ecosystem. Purpose: strategic purposes (e.g. enterprise architecture model), tactical, operational. Cross-level tasks to be supported: alignment, visualization, ambiguity detection, approximation (find similar models), annotating, linking, conflicts. Factors affecting success, failure, utility of modelling. Model lifecycles with different paces, scopes, etc. in lifecycle.

For support of grassroots modeling:

- Lightweight, no entry barrier (e.g. no fixed notation, not driven by specific concerns (what does “lightweight” really mean? What interactions / visualization/ concepts are established in what local practice?))
- Local practice of modeling welcome – linking to other models happens on demand, if required
- Support actual use situations
- Backbone powerful but invisible to the users: built-in collaboration features, social network integrated, marketplace of existing / established “modlets”

For traditional enterprise modeling: What kind of use scenarios are of major importance for supporting agility / efficiency in organisations?

In order to develop good quality models for enterprise engineering: Understand the “end” – actual need of users, designers, different roles. Required role structure “backbone” in the organisation. Model and content store providing “cross level features”. More specific support of different integration tasks and requirements between different modeling approaches and task (differentiated integration supports). (How to) find commonalities between different local practices and identify candidates for reuse / propagating to other communities – requires de-contextualization of local practice. Another kind of education of people in modeling (start at school to do modelling?). Understand the required level of maturity for the purpose at

hand – and what defines maturity. We need to move easily between the extremes of model representation. Increasing the value of the models by the human actors depending on the purpose/goals.

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