# Lecture Notes in Business Information Processing 422

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Boris Shishkov (Ed.)

# Business Modeling and Software Design

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# Preface

This book contains the *proceedings* of **BMSD 2021** (the 11th International Symposium on **Business Modeling and Software Design**), held in *Sofia*, *Bulgaria*, on 5-7 July (http://www.is-bmsd.org). BMSD is an annual event that brings together researchers and practitioners interested in enterprise modeling and its relation to software specification.

The BMSD Community is inspiring! Many of us met *physically* in Berlin last year, for the 10th edition of the symposium, being so very happy about that. Probably few of us would have imagined how special such a physical meeting would be, in the current pandemic period. It is marked not only by huge stress among most people (in Europe and beyond) but also by an increasing pressure over many systems: Hospitals were burdened by too many patients in their intensive-care units; Border police officers were pressed, pushed to control again the EU-internal borders; Police were not only expected to fight crime but also to control the population by enforcing the imposed restrictions; Universities had to go online, with no time to prepare; Travel companies were excessively burdened to also consider the health status of their customers; Logistics was severely affected by numerous travel restrictions; Banks had to accommodate new (credit) schemes for the benefit of "problematic" customers; and so on. Unfortunately, *Information and Communication Technology* (ICT) did not bring benefits in this regard as much as we all hoped for. This concerns an *expectations mismatch* between Society and *Big Tech* (BT): (i) Society expected that BT would truly aim to meet user needs (especially during the pandemic), rather than re-branding and imposing existing technology-driven solutions; (ii) BT expected from Society more trust and cooperativeness rather than suspicion. We argue that very few existing IT solutions have undergone essential developments in response to the changing and increasing societal needs during the pandemic, neither have we seen cutting-edge IT innovations in the 2020-21 period. But what we see instead is an increasing *power* of BT, that goes beyond the boundaries of ICT, entering the territory of *politics*. Some top BT representatives seem to be less interested in stimulating the creation of new ICT-related solutions for the benefit of people, being at the same time more interested in entering healthcare-related discussions and stating opinions about how people should live. Last but not least, BT has accumulated abundant wealth in the abovementioned period, and this raises questions. Can we speak of a delivery of ICT-related solutions in response to user needs, for the benefit of Society, and in concert with human values and public values? Do we observe BT doing things that normally politicians should do? Are users "the King" whose needs are to be identified and reflected in REQUIREMENTS that in turn "govern" the ICT developments or is it the case that BT "determines" what the user needs SHOULD be? We have very simple examples from the last several years: (i) A laptop purchased several years ago is very similar (as it concerns its key features) to the corresponding model of today; (ii) Some big operating systems are enforcing updates almost every week but what we get as users remains nearly the same; (iii) The

platforms we are using for routing, e-banking, and so on are mainly changing their fancy banners and colors but essentially what we benefit from using them remains the same. Those examples indicate that often a new ICT project is realized just for the sake of realizing yet another ICT project. USER NEEDS and REQUIREMENTS are not seen on the horizon. More and more we observe R&D projects realized by huge interdisciplinary teams where there is a HUGE GAP between the work of domain specialists and the work of technology developers. Domain specialists have their attitudes but are often unable to judge how a proposed ICT solution is relevant to particular domain-specific needs and whether at all the ICT-system-to be would contribute to any relevant improvements. This gives "unlimited power" in the hands of ICT developers who would often "massage" some of their existing products and re-shape +re-brand them as "new" products. The funding is provided and a "new product" is delivered. If in several years it would appear that the product is not good enough, this may just lead to yet another project. Is this what we want? Is this what we need? Probably we should all be listening to the WIND OF CHANGE! We should bring back ICT DEVELOPMENT and SOFTWARE DESIGN to its CREATIVE ROOTS and SENSITIVITY to USER NEEDS. Not always BOTTOM-UP (technology-driven) solutions are the best for Society, especially if it is very difficult for other stakeholders to adequately perceive the relevance and utility of the proposed technical and technological solution(s). Often a USER-CENTRIC approach would be better in this regard, especially if the demands of domain specialists are properly codified in MODELS that in turn would "fuel" the technical specifications. And this all should be essentially driven by the goal of satisfying user needs, as stated in the preface of the BMSD 2020 Proceedings. As also mentioned in the BMSD 2020 preface, THE way of achieving this is to methodologically align business (enterprise) modeling and software design, this bringing the BMSD Community together, inspired to contribute to the area of **ENTERPRISE INFORMATION SYSTEMS**.

Since 2011, we have enjoyed **ten successful BMSD editions**. The first BMSD edition (**2011**) took place in **Sofia**, **Bulgaria**, and the theme of BMSD 2011 was: "Business Models and Advanced Software Systems." The second BMSD edition (2012) took place in **Geneva**, **Switzerland**, with the theme: "From Business Modeling to Service-Oriented Solutions." The third BMSD edition (**2013**) took place in **Noordwijkerhout**, **The Netherlands**, and the theme was: "Enterprise Engineering and Software Generation." The fourth BMSD edition (**2014**) took place in **Luxembourg**, **Grand Duchy of Luxembourg**, and the theme was: "Generic Business Modeling Patterns and Software Re-Use." The fifth BMSD edition (2015) took place in **Milan**, **Italy**, with the theme: "Toward Adaptable Information Systems." The sixth BMSD edition (**2016**) took place in **Rhodes**, **Greece**, and had the theme: "Integrating Data Analytics in Enterprise Modeling and Software Development." The seventh BMSD edition (2017) took place in **Barcelona**, **Spain**, and the theme was: "Modeling Viewpoints and Overall Consistency." The eighth BMSD edition (**2018**) took place in **Vienna**, **Austria**, with the theme: "Enterprise Engineering and Software Engineering - Processes and Systems for the Future." The ninth BMSD edition (**2019**) took place in **Lisbon**, **Portugal**, and the theme of BMSD 2019 was: "Reflecting Human Authority and Responsibility in Enterprise Models and Software Specifications". The tenth BMSD edition (**2020**) took place in **Berlin**, **Germany**, and the theme of BMSD 2020

was: "Towards Knowledge-Driven Enterprise Information Systems". The current edition brings BMSD back to where it once started – Sofia, Bulgaria. BMSD 2021 marks the **ELEVENTH EVENT**, with the theme: "**Towards Enterprises and Software that are Resilient Against Disruptive Events**."

We are proud to have attracted distinguished guests as keynote lecturers, who are renowned experts in their fields: **Manfred Reichert**, *Ulm University*, Germany (2020), **Mathias Weske**, *HPI - University of Potsdam*, Germany (2020), **Jose Tribolet**, *IST - University of Lisbon*, Portugal (2019), **Jan Mendling**, *WU Vienna*, Austria (2018), **Roy Oberhauser**, *Aalen University*, Germany (2018), **Norbert Gronau**, *University of Potsdam*, Germany (2017), **Oscar Pastor**, *Polytechnic University of Valencia*, Spain (2017), **Alexander Verbraeck**, *Delft University of Technology*, The Netherlands (2017), **Paris Avgeriou**, *University of Groningen*, The Netherlands (2016), **Jan Juerjens**, *University of Koblenz-Landau*, Germany (2016), **Mathias Kirchmer**, *BPM-D*, USA (2016), **Marijn Janssen**, *Delft University of Technology*, The Netherlands (2015), **Barbara Pernici**, *Politecnico di Milano*, Italy (2015), **Hend***erik* **Proper**, *Public Research Centre Henri Tudor*, Grand Duchy of Luxembourg (2014), **Roel Wieringa**, *University of Twente*, The Netherlands (2014), **Kecheng Liu**, *University of Reading*, UK (2013), **Marco Aiello**, *University of Groningen*, The Netherlands (2013), **Leszek Maciaszek**, *Wroclaw University of Economics*, Poland (2013), **Jan L. G. Dietz**, *Delft University of Technology*, The Netherlands (2012), **Ivan Ivanov**, *SUNY Empire State College*, USA (2012), **Dimitri Konstantas**, *University of Geneva*, Switzerland (2012), **Marten van Sinderen**, *University of Twente*, The Netherlands (2012), **Mehmet Aksit**, *University of Twente*, The Netherlands (2011), **Dimitar Christozov**, *American University in Bulgaria – Blagoevgrad*, Bulgaria (2011), **Bart Nieuwenhuis**, *University of Twente*, The Netherlands (2011), and **Hermann Maurer**, *Graz University of Technology*, Austria (2011).

The high quality of the BMSD 2021 technical program is enhanced by two keynote lectures delivered by outstanding guests and previous BMSD keynote speakers: **Norbert Gronau**, *University of Potsdam*, Germany (the title of his lecture is: "The Socio-Technical Factory of the Future: How AI and Human Can Work Together") and **Alexander Verbraeck**, *Delft University of Technology*, The Netherlands (the title of his lecture is: "Resilient Enterprise Information Systems"). Also, the presence (physically or distantly) of former BMSD keynote lecturers is much appreciated: *Roy Oberhauser* (2018), *Mathias Kirchmer* (2016), *Marijn Janssen* (2015), and *Marten van Sinderen* (2012). The technical program is further enriched by a panel discussion (featured by the participation of some of the abovementioned outstanding scientists) and also by other discussions stimulating *community building* and facilitating possible *R&D project acquisition initiatives*. Those special activities are definitely contributing to maintaining the event's high quality and inspiring our steady and motivated Community.

The BMSD 2021 Technical Program Committee consists of a Chair and 106 Members from 36 countries (*Australia*, *Austria*, *Brazil*, *Bulgaria*, *Canada*, *China*, *Colombia*, *Denmark*, *Egypt*, *Estonia*, *Finland*, *France*, *Germany*, *Greece, India*, *Indonesia*, *Italy*, *Lithuania*, *Grand Duchy of Luxembourg*, *Malaysia*, *Mexico*, *New Zealand*, *Palestine*, *Poland*, *Portugal*, *Russia*, *Singapore*, *Slovak Republic*, *Slovenia*, *Spain*, *Sweden*, *Switzerland*, *Taiwan*, *The Netherlands*, *UK*, and *USA*, listed

alphabetically) – all of them competent and enthusiastic representatives of prestigious organizations.

In organizing BMSD 2021, we have observed **highest ethical standards**: We guarantee *at least two reviews per submitted paper* (assuming reviews of adequate quality), under the condition that the paper fulfills the BMSD 2021 requirements. In assigning a paper for reviewing, it is our responsibility to *provide reviewers that have relevant expertise*. Sticking to a **double-blind review process**, we guarantee that a reviewer would not know who the authors of the reviewed paper are (we send anonymized versions of the papers to the reviewers) and an author would not know who has reviewed his/her paper. We require that a reviewer *respects the content of the reviewed paper* and does not disclose (parts of) its content to third parties before the symposium (and also after the symposium in case the manuscript gets rejected). We *guarantee against conflict of interests*, by not assigning papers for reviewing by reviewers who are immediate colleagues of any of the co-authors. In our decisions to accept/reject papers, we **guarantee against any discrimination based on age, gender, race, or religion**. As it concerns the EU data protection standards, **we stick to the GDPR requirements**.

We have demonstrated for a 11th consecutive year a high quality of papers. We are proud to have succeeded in establishing and maintaining (for many years already) a high scientific quality (as it concerns the symposium itself) and a stimulating collaborative atmosphere; also, our Community is inspired to share ideas and experiences.

As mentioned already, BMSD is essentially leaning toward **ENTERPRISE INFORMATION SYSTEMS (EIS)**, by considering the **MODELING OF ENTERPRISES AND BUSINESS PROCESSES** as a basis for **SPECIFYING SOFTWARE**. Further, in the broader EIS context, BMSD 2021 addresses a large number of research areas and topics, as follows:

› **BUSINESS PROCESSES AND ENTERPRISE ENGINEERING** - *enterprise systems; enterprise system environments and context; construction and function; actor roles; signs and affordances; transactions; business processes; business process coordination; business process optimization; business process management and strategy execution; production acts and coordination acts; regulations and business rules; enterprise (re-) engineering; enterprise interoperability; inter-enterprise coordination; enterprise engineering and architectural governance; enterprise engineering and software generation; enterprise innovation.*

› **BUSINESS MODELS AND REQUIREMENTS** - *essential business models; re-usable business models; business value models; business process models; business goal models; integrating data analytics in business modeling; semantics and business data modeling; pragmatics and business behavior modeling; business modeling viewpoints and overall consistency; business modeling landscapes; requirements elicitation; domain-imposed and user-defined requirements; requirements specification and modeling; requirements analysis and verification; requirements evolution; requirements traceability; usability and requirements elicitation.*

› **BUSINESS MODELS AND SERVICES** - *enterprise engineering and service science; service-oriented enterprises; from business modeling to service-oriented solutions; business modeling for software-based services; service engineering; business-goals-driven service discovery and modeling; technology-independent and*

*platform-specific service modeling; re-usable service models; business-rules-driven service composition; web services; autonomic service behavior; context-aware service behavior; service interoperability; change impact analysis and service management; service monitoring and quality of service; services for IoT applications; service innovation*.

› **BUSINESS MODELS AND SOFTWARE** - *enterprise engineering and software development; model-driven engineering; co-design of business and IT systems; business-IT alignment and traceability; alignment between IT architecture and business strategy; business strategy and technical debt; business-modeling-driven software generation; normalized systems and combinatorial effects; software generation and dependency analysis; component-based business-software alignment; objects, components, and modeling patterns; generic business modeling patterns and software re-use; business rules and software specification; business goals and software integration; business innovation and software evolution; software technology maturity models; domain-specific models; croscutting concerns - security, privacy, distribution, recoverability, logging, performance monitoring*.

› **INFORMATION SYSTEMS ARCHITECTURES AND PARADIGMS** - *enterprise architectures; service-oriented computing; software architectures; cloud computing; autonomic computing (and intelligent software behavior); context-aware computing (and adaptable software systems); affective computing (and user-aware software systems); aspect-oriented computing (and non-functional requirements); architectural styles; architectural viewpoints*.

› **DATA ASPECTS IN BUSINESS MODELING AND SOFTWARE DEVELOPMENT** - *data modeling in business processes; data flows and business modeling; databases, OLTP, and business processes; data warehouses, OLAP, and business analytics; data analysis, data semantics, redundancy, and quality-of-data; data mining, knowledge discovery, and knowledge management; information security and business process modeling; categorization, classification, regression, and clustering; cluster analysis and predictive analysis; ontologies and decision trees; decision tree induction and information gain; business processes and entropy; machine learning and deep learning - an enterprise perspective; uncertainty and context states; statistical data analysis and probabilistic business models*.

› **BLOCKCHAIN-BASED BUSINESS MODELS AND INFORMATION SYSTEMS** - *smart contracts; blockchains for business process management; blockchain schemes for decentralization; the blockchain architecture - implications for systems and business processes; blockchains and the future of enterprise information systems; blockchains and security/privacy/trust issues*.

› **IoT AND IMPLICATIONS FOR ENTERPRISE INFORMATION SYSTEMS** - *the IoT paradigm; IoT data collection and aggregation; business models and IoT; IoT-based software solutions; IoT and context-awareness; IoT and public values; IoT applications: smart cities, e-Health, smart manufacturing*.

BMSD 2021 received 61 paper submissions from which 27 papers were selected for publication in the symposium proceedings. Of these papers, 14 were selected for a 30-minute oral presentation (full papers), leading to a **full-paper acceptance ratio of 23%** (compared to 22% in 2019 and 19% in 2018, and exactly the same as in the previous year) - an indication of our intention to preserve a high-quality forum for the

next editions of the symposium. The BMSD 2021 keynote lecturers and authors come from: Austria, Bulgaria, China, Colombia, Finland, Germany, Indonesia, Italy, Norway, Pakistan, Portugal, Serbia, Sweden, Switzerland, The Netherlands, and USA (listed alphabetically); that makes a total of 16 countries (compared to 10 in 2019, 15 in 2018, 20 in 2017, 16 in 2016, 21 in 2015, 21 in 2014, 14 in 2013, 11 in 2012, 10 in 2011, and exactly the same as in the previous year) to justify a strong international presence. Three countries have been represented at all eleven BMSD editions so far – **Bulgaria**, **Germany**, and **The Netherlands** – indicating a strong European influence.

Clustering BMSD papers is always inspiring because this gives different perspectives with regard to the challenge of **adequately specifying software based on enterprise modeling**. As it concerns the BMSD 2021 full papers, some of them are directed towards BUSINESS MODELING while others are touching upon CONTEXT-AWARENESS; some papers address issues concerning SECURITY and PRIVACY while others are leaning towards KNOWLEDGE MANAGEMENT and GOVERNANCE; finally, there are papers addressing software development, by considering ARCHITECTURES and DESIGN. As it concerns the BMSD 2021 short papers, some of them are more CONCEPTUAL, touching upon information systems, the digital transformation, and enterprise architectures, while others are leaning towards REQUIREMENTS; some papers are directed towards SOFTWARE ENGINEERING while others are touching upon issues related to DATA, and still others are considering PROJECT TIME ANALYSIS and SMART CONTRACTING; finally, there are application-oriented papers featuring INTERNET-of-THINGS and SMART CITIES.

BMSD 2021 was organized and sponsored by the *Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology* (*IICREST*) and technically co-sponsored by *BPM-D*. Cooperating organizations were *Aristotle University of Thessaloniki* (*AUTH*), *Delft University of Technology* (*TU Delft*), the UTwente *Digital Society Institute* (*DSI*), the *Dutch Research School for Information and Knowledge Systems* (*SIKS*), and *AMAKOTA Ltd*.

Organizing this interesting and successful symposium required the dedicated efforts of many people. First, we thank the *authors*, whose research and development achievements are recorded here. Next, the *Program Committee members* each deserve credit for the diligent and rigorous peer reviewing. Further, we would like to mention the excellent organization provided by the *IICREST team* (supported by its *logistics partner, AMAKOTA Ltd.*) – the team (words of gratitude to *Aglika Bogomilova*!) did all the necessary work for delivering a stimulating and productive event, supported by the *Hilton-Sofia team* (words of gratitude to *Katia Kovacheva*!) and also by Christoph Hartmann. We are grateful to *Springer* for their willingness to publish the current proceedings and we would like to especially mention *Ralf Gerstner* and *Christine Reiss*, appreciating their professionalism and patience (regarding the preparation of the symposium proceedings). We are certainly grateful to our *keynote lecturers*, *Prof. Gronau* and *Prof. Verbraeck*, for their invaluable contribution and for their taking the time to synthesize and deliver their talks. I take the opportunity to also personally

address them: Alexander, Norbert, your continuing support to BMSD in so many ways is more than appreciated!

We wish you inspiring reading! We look forward to meeting you next year in *Fribourg*, *Switzerland*, for the *12th International Symposium on Business Modeling and Software Design* (*BMSD 2022*), details of which will be made available on http://www.is-bmsd.org.

June 2021 Boris Shishkov

# Organization

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## Invited Speakers

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| Norbert Gronau | University of Potsdam, Germany |
| Alexander Verbraeck | Delft University of Technology, The Netherlands |

# Abstracts of Keynote Lectures

# The Socio-Technical Factory of the Future: How AI and Human Can Work Together

Norbert Gronau

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**Abstract.** We are in the midst of the 4th industrial revolution. Small inexpensive computers with very high processing ability are more and more used in factories and logistical networks to increase the competitive ability of participating companies. The keynote of Prof. Gronau, member of the German Academy of Technical Sciences ACATECH and director of the 4IR research center Potsdam, Germany, will provide an overview about these achievements and will address the question, which position belongs to the humans in the factory of the future? As Artificial Intelligence (AI) is also enlarging its capabilities, it is possible to create a joint AI-human team in the factory. The keynote will show the elements of such a factory system, how to achieve it and its benefits for humans and the company as well.

# Resilient Enterprise Information Systems

Alexander Verbraeck

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**Abstract.** Crises such as cyber-attacks and the Corona pandemic have unfortunately demonstrated that many of the important information systems in businesses and Government are not resilient. After disruptive events, these systems have long periods of reduced service levels, and it takes major efforts to restore the systems to their normal state of operation. After a brief introduction into the topic of resilience, we will discuss how risk management frameworks, originating from the project management field and the safety sciences field, can help to assess the vulnerability of information systems or their components. Combined with an evaluation of the criticality of the components, a decision can be made to invest in either reducing their vulnerability or their criticality, or both. Techniques for improving the resilience of information systems are readily available from systems engineering and range from decoupling important parts so they can function independently to duplication of subsystems that provide critical services. Many of these are already being used as part of the design of complex information systems but the deployment is often not based on a structured assessment to make the entire information system more resilient. The presentation will illustrate the usage of risk assessment methods and architectural solutions with a number of examples.

# Contents

## Full Papers

**Short Papers**