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EDITORIAL

# Models for the digital transformation

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"Digital transformation" is currently an important trend that penetrates many industrial and societal domains. The phrase is also emerging as a buzzword that allows different stakeholders to inject various forms of innovation into their respective company, business, government, academic institution, or other public services. The nuances of digital transformation are broad and have not yet been defined precisely, but even job advertisements often contain the phrase.

Deconstructing the term from its two primary words, we identify two well-known concepts. "Transformation" describes a general process that starts with some initial situation that moves toward a changed, and supposedly better situation. May be that in this case the word transformation is not the best word choice because the underlying transformation may never meet a stable end, but rather undergo a continual set of evolutionary optimizations related to new forms of business, production, logistics, medicine or other changes within the targeted domain. "Digital" suggests that many changes in society, business and industry will be driven by information technologies that allow data to be processed in real-time and even used to intelligently derive information to finally to provide stakeholders with improved knowledge about their processes and products. Downstream digitization would also allow optimization, automation activities and production techniques of various forms.

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Of course, within the context of SoSyM, the key question is the extent to which models can aid the emerging digital transformation needs.

As SoSyM readers may observe, models have much potential toward achieving the goals of digital transformation. Below are a few possible contexts for application, among others that we are sure could be suggested by the SoSyM readership:

(1) One of our Editors, Ulrich Frank, recently wrote that models can be used beneficially to mitigate the differences and challenges that emerge between different worlds that speak very unique languages. This becomes obvious when considering the various stakeholders that come into contact with Digital Products or services. Each stakeholder may have individual domain-specific terms to describe his or her needs, capabilities, and unique information resources.
(2) Digital transformation often co-exists with large data sets that are associated with some processing need of the transformation context. Data has structure. For an explicit, well-founded handling of this data, models are necessary to describe the data structure, but also how to manipulate the data and retrieve it efficiently. Transformation models describe how to slice, select, join, or aggregate data to retrieve useful information. Beyond manipulation of data, there is much software that is necessary to handle, manage and visualize this data. In the future, traditional software engineering techniques may use models to design such systems, or models at runtime will describe specific techniques within a rather generic software package (e.g., database, statistics packages or visualization components).
(3) The design of digital products and the development of product lines using digital technologies will lead to a

very challenging integration problem for the physical components of a system, as well as the development methodologies and their tools. Many of these tools use very specific forms of models, written in proprietary or semi-standardized modeling languages, that will need a syntactic, semantic and tool-based integration.

(4) While traditional engineering uses human-generated models to prescribe aspects of the system under development, machine learning and data mining techniques have the potential to reverse this relation by extracting models from sets of running data. It will be interesting to see how prescriptive and extracted models fit together, if at all.

There is a deep list of research topics that need to be explored in order to derive the understanding that will bring a pure data-driven world together with prescriptive design models. Particularly, the application of machine learning currently too often relearns already well-known models, because prescriptive models and machine learning are not well integrated. Colleagues recently applied big data analytics in a larger industrial project that at first and foremost re-uncovered basic physical laws from a set of production data. While this result may be interesting from a machine learning perspective, the end result was not very helpful given the physical laws were already well-known.

In the current discussion in the research literature about digital transformation, models do not play a prominent role. This may be because many people researching and applying digital transformation are not aware of the possibilities and capabilities of using models of appropriate languages. It may also be the case that models and modeling languages have become mainstream in many domains, such that it is not regarded as a research topic anymore, but more as a helpful tool that is commonly available and can be used out of the box. While the latter points to a desirable level of maturity for models, there is still plenty of research and application opportunity for modeling, model languages, as well as generative and analytical tooling, that can be applied to the ongoing pursuits of digital transformation.

**Content of this Issue**

This issue contains the Special Issue on "Modeling—Foundations and Applications", with Ana Moreira, Bernhard Schätz, Peter Clarke, and Antonio Vallecillo as Guest Editors. The included papers are described in the Guest Editorial. This issue also contains five Regular Papers:

- "Aspectual Templates in UML" by Gilles Vanwormhoudt, Olivier Caron, and Bernard Carré
- "Proactive Modeling: A New Model Intelligence Technique" by James Hill, Tanumoy Pati, and Sowmya Kolli
- "Using Contexts to Extract Models from Code" by Lucio Duarte, Jeff Kramer, and Sebastian Uchitel
- "Model-based Tool Support for Tactical Data Links: An Experience Report from the Defence Domain" by Dimitrios Kolovos, Suraj Ajit, Chris Holmes, Julian Johnson, and Richard Paige
- "Contract-based Modeling and Verification of Timed Safety Requirements within SysML" by Iulia Dragomir, Iulian Ober, and Christian Percebois.