Editorial

Eliab Z. Opiyo* and Imre Horváth

Faculty of Industrial Design Engineering,
Delft University of Technology,
Landbergstraat 15, 2628CE, Delft, The Netherlands
Email: e.z.opiyo@tudelft.nl
Email: i.horvath@tudelft.nl
*Corresponding author

Biographical notes: Eliab Z. Opiyo is an Assistant Professor at the Faculty of Industrial Design Engineering, Delft University of Technology, in the Netherlands. He obtained his PhD degree from the Delft University of Technology in 2003 and MSc in Computer Aided Design and Manufacturing from the Cranfield Institute of Technology (now Cranfield University), UK in 1992. His current research interests include modelling of complex systems, forecasting, product design and visualisation, software prototyping, and requirements engineering.

Imre Horváth is a Full Professor of Cyber-Physical Systems Innovation at the Faculty of Industrial Design Engineering, Delft University of Technology, in the Netherlands. He earned his Dr. Univ. in 1987 and PhD from the TU Budapest, Hungary in 1994. His current interests include research in cognitive engineering of smart cyber-physical systems, design application of mobile and ubiquitous technologies, systemisation of design research, affordances-based innovation, and teleconferencing-based active learning.

It is widely recognised that software and cyber components are becoming important functional elements in many of today's physical products and processes. As a result, products and systems are becoming more and more complex from the perspective of how they are developed, as well as from the perspective of how they provide services or are put to use. The broadening range of functionalities and the growing complexities together raise many challenges for product and system developers, in particular from an information management point of view. Many processes are also becoming more complex due to use of vastly intricate technologies. Under the title 'Information management challenges in complex processes and systems', this special issue intends to cast light on some of the challenges of conceptualisation, design, implementation, operation, and utilisation of complex products and systems, and of managing complex processes.

This special issue consists of five revised and extended papers that were initially presented at the 10th International Symposium on Tools and Methods of Competitive Engineering (TMCE) held in Budapest, Hungary from 19–23 May, 2014. Five broad challenges are discussed in this special issue, namely:

a managing heterogeneous information

b managing information in complex operations

c dealing with awareness in complex man-machine interaction (MMI)

d handling documentation in iterative product design processes

e conceptualising, modelling, and planning the future of complex products or systems upfront.

Obviously, these represent only a tiny subset of diverse challenges typically faced in developing, operating or managing complex products, systems, or processes.

Researchers in bio-medical imaging (BMI) are frequently challenged by the need of dynamically processing large amounts of heterogeneous information. Typically, large-scale sharing and reusing of information are among the most commonly recurring tasks. Although several data management systems have been developed to handle data in neuroimaging field, they have limitations in terms of providing comprehensive data integration. In the paper entitled 'PLM as a strategy for the management of heterogeneous information in bio-medical imaging field', M. Allanic, P-Y. Hervé, A. Durupt, M. Joliot, P. Boutinaud, and B. Eynard argue that the manufacturing industry was confronted with similar issues 20 years ago and that product lifecycle management (PLM) systems were developed to facilitate sharing and managing information all along the lifecycle of products and among teams of developers. The authors claim that using PLM systems is a relevant strategy to manage information in BMI research studies. Therefore, they propose a generic, flexible and PLM-oriented data model, called BMI-lifecycle management (BMI-LM), and a neuroimaging classification, which they claim provides flexibility to the information management system, is expandable, and allows easy sharing and reuse of data. The authors developed a pilot implementation of a PLM system and applied it to garner feedback from users. They also claim that, compared to databases used in the neuroimaging domain, their PLM system enlarges the scope of BMI information management possibilities, facilitates management of all kind of data, provides efficient access management, and allows complete data provenance.

In their paper entitled 'Cyber-physical infomobility for tourism application', A. Smirnov, N. Shilov, A. Kashevnik, and A. Ponomarev propose an approach, which integrates models and methods enabling ad-hoc configuration of resources for multimodal logistics, and a reference model for the concerned domain of application. Their approach is based on dynamic optimisation of the route and transportation means and they claim that it takes into account user preferences together with unexpected and unexpressed needs. The main idea behind the proposed concept of virtual tourist hub is to arrange a tourist trip based on the available schedules, capabilities, and environment-friendliness of transportation and attraction providers, and the current and foreseen availability and occupancy of the available transportation means and attraction services. Their approach assumes the use of a context-based group commending system for generating recommendations for the tourists. The authors have realised the concept in the form of a tourist assistant, and illustrate their approach with an e-tourism case study. They claim that the proposed approach works efficiently and that the developed tourist assistant response time is not more than a few seconds for every operation. They also claim that the proposed approach helps tourists plan the time of attending attractions and excursions using their mobile devices, depending on the context information about the situation at hand and their own preferences. Furthermore, they argue that user profile information can be kept and used intelligently, and that, unlike the existing approaches,

the proposed approach allows monitoring of the situation in an entire city or region, and provides context-driven update of travel plans.

In the paper entitled 'A situation awareness analysis scheme to identify deficiencies of complex man-machine interactions', E. van Doorn, Z. Rusák, and I. Horváth explore the challenge of managing complex human-machine interactions by improving situation awareness (SA). They report on a systematic study and propose a transparent and effective analysis scheme to identify pitfalls. They argue that existing theories are not suitable to clearly define the required situation awareness (RSA) in complex MMI contexts, and, as a result, the pitfalls in MMI are difficult to recognise and resolve. The authors analyse the applications of the existing SA theories in information intensive task environments, and identify the principal limitations. The authors coin an explicit definition of RSA and propose a structured analysis scheme which, they applied in nautical traffic management to identify the deficiencies in supporting SA. They found that approximately 80% of the identified deficiencies are related to how MMI supports human information processing. The application of the proposed analysis scheme in practice showed that the pieces of information considered to be important for operators differ from those pieces of information, which are considered to be important in general terms. This finding raised the question whether designers need to use different techniques to visualise information that is part of RSA and that is not part of RSA. They attempt to address this question in their ongoing research.

Iterations are inherently instinctive and subtle aspect of the product design process. They typically arise due to some inconsistencies between requirements and solution concepts. In their paper entitled 'The influence of documenting assumed values of product properties on the number of iterations in the design process – first observations', A. Sadlauer, P. Hehenberger, and K. Zeman argue that not all iterations are beneficial and that some are unnecessary. They attribute a large portion of unnecessary iterations to what they refer to as 'false iteration return points'. They claim that identification of potentially false assumptions about product properties may indicate 'true' or 'likely' iteration return points. They conducted a questionnaire survey and used a design experiment to further analyse the influence of documentation on the number of iterations, the ratio of obsolete iterations, and the success of the task. They argue that the design experiment showed that a manual documentation of assumptions seemed to decrease the number of iterations, but without having a positive influence on the quality of the results or success. They also argue that a complete documentation of the history of assumed parameters might not be the best solution, due to information overload. Based on the results of the above investigations, they propose a network-based assumption documentation with meta-information about the confidence in the assumption for the identification and ranking of potential iteration return points.

Finally, in the paper entitled 'A feature-based approach to conceptualisation, upfront modelling, and planning for the future of complex systems', E.Z. Opiyo deals with the challenges of conceptualising, modelling, and reconnoitering of complex systems. The main question is how physical or structural manifestation, functioning, performance, cost, or technical operation can be forecasted in the period between when an opportunity for a new system is first considered, and when the idea is judged to be ready to enter formal development. The techniques traditionally used in conceptualisation, modelling and planning of the future of novel systems cannot be applied right away in early development phases to model and predict aspects such as the performance, assembly

time, cost, or implications of investing in complex systems with intertwined and synergistically operating physical, software and cyber components. Specifically, the challenges to be dealt with include how to identify features, how to model the system, synergies, and operations, and how to achieve accurate prediction of future prospects. A scheme for identifying components and features, and for using the obtained models as the basis for forecasting, and techniques for modelling (including the operations and synergies) of the elements have been developed. The paper presents the proposed techniques and the scheme, and illustrates their applicability by using a practical example of a complex medical rehabilitation system. The author argues that the proposed techniques and scheme provide a systematic and effective way of identifying components and features, and of upfront modelling and planning for the future of complex systems with diverse physical, software, and/or cyber components.

In conclusion, the selected papers deal with several challenges, but could not provide an exhaustive overview of the broad palette. Each of the developed solutions is tied to a specific application domain and context. Overall, it is imperative to carefully analyse the problem and understand the context of the product, system, or process in question. This should include a careful analysis of the needs and a sensible selection of solution concepts for the problem or application context at hand. The guest editors of this special issue hope that the selected papers provide sufficient practice-oriented examples. They extend their sincere thanks and appreciation to all authors for their valuable contributions. They also thank all reviewers for the efforts and time they spent in reviewing initial drafts of the manuscripts.