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Fifth International Workshop on Human Factors in Modeling / Modeling of Human Factors (HuFaMo'21)

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***Abstract*—Studying human factors and experiences in modeling helps to gain knowledge on the process and use of modeling in practice to optimize system outcomes and user well-being. Moreover, to better support the human aspects of stakeholders and end-users of the software, incorporating the human aspects into software engineering processes from the early modeling and design stages is essential. Considering human factors in software design involves not only 1) studying in detail the interactions between users (humans), but also 2) studying the human factors of the end-users of the system. The HuFaMo workshop was established in 2015 to promote this form of research by creating a venue to discuss and disseminate these topics. The HuFaMo Workshop originally aimed at studying human factors for software systems (implemented or not) allowing humans to model. Hosted within the MODELS conference, the first four editions of the workshop benefited from a high-quality audience, allowing significant progress on this issue. For this fifth edition, we have widened the scope of the workshop to consider the modeling of human factors during the design of the software as well. This helps to study all types of relationships that modeling and human factors can have and their impact on processes, products, and end-users as well as others that might be affected by the system.**

I. Introduction

Software users are different, i.e., have diverse characteristics, such as differing personalities, technical proficiency, emotional reactions to software systems, socio-economic status, gender, age, culture, language, and preferences. Capturing and supporting the human factors at requirements or design levels are essential for designing and modeling human-centric software systems that fit the end-users of the systems. Moreover, since modeling is an intrinsically human endeavor, many of the questions related to modeling can only be answered by empirical studies. The HuFaMo workshop series is a venue for early-stage empirical research involving human factors in modeling and design. Our goal is to improve the state of science and professionalism in empirical research in the MDE community. We perceive MODELS to be a high-quality venue that does not yet sufficiently reflect the **modeling and design of human factors** as well as the **human factor in modeling and design**. This workshop is an attempt to compensate for what we deem is a major aspect of modeling, as other venues (such as ICSE) have already acknowledged for other areas of Software Engineering.

HuFaMo covers two themes: 1) Modeling and design of human factors and 2) Human factors in modeling and design. Modeling and design of human factors in an essential step toward designing human-centric software systems. Software is designed and built primarily to solve human needs. However, many software systems have issues with cost overruns (badly captured requirements); hard-to-maintain and dangerous solutions (incorrect technology choice, usage or deployment); and hard-to-use software that does not meet users' needs (poor understanding of user needs and poor design). Many of these problems can be traced to a lack of understanding and incorporation of end-user human factors. This workshop focuses on showcasing emerging approaches to better incorporating the human aspects into modeling and design of software systems. This includes work focusing on better modeling the

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human aspects of stakeholders and end-users of the software, such as age, gender, personality, emotions, language, disability, preferences and so on.

In relation to Human factors in modeling and design, empirical studies are classic milestones of research projects on human factors in modeling. Surveys, case studies or controlled experiments are indeed means to validate steps from the initial idea to the final theory. These studies require substantial amount of time and resources. Careful preparation is therefore essential to avoid mistakes with severe consequences. With a program committee and an audience respectively composed of experienced and enthusiastic researchers, the HuFaMo workshop is the perfect place to complete such preparation and consequently to make more significant progress in this key area.

MODELS hosted five editions of HuFaMo (2015, 2016, 2018, 2019, 2021). The number of participants ranged from 15 to 30, with the number of papers presented during the five editions as (6-5-6-3-6). There were also two keynotes in the last edition. This shows that a growing part of the MODELS community is still concerned about this subject. In this edition we are adding another theme to the workshop, as the "human factors in modeling" which will help to attract more participants and keynote speakers.

II. The fifth edition of HuFaMo

The fifth edition (HuFaMo 2021) was conducted virtually due to the COVID 19 ongoing travel restrictions. HuFaMo 2021 was held in conjunction with the ACM/IEEE 24nd International Conference on Model Driven Engineering Languages and Systems (MODELS 2021), which is the premier conference on systems and software modeling. In this fifth edition, HuFaMo attracted a considerable number of participants, including researchers and practitioners. The workshop included the discussion of six papers and two keynotes.

III. Paper presentations

The HuFaMo Program Committee selected six papers for presentation in the workshop, representing a spectrum of views on human factors in software modeling. Here below we briefly outline some of the main contributions of each of those papers and our reflections on them.

Ventirozos et al. [1] compare and contrast two approaches for modelling workflows, Behavior Trees and DX-MAN, to find the most suitable semantic representation for handling IoT cooking workflows in the context of end-user development. Behaviour Tree is a structured alternative to finite state machines with applications in game agent design. DX-MAN is a service composition technique which represents a set of possible workflows rather than a single workflow, allowing the user or an automated MAPE-K loop to select the desired workflow from the space of possible options. A kitchen underpinned by the Internet of Things (IoT) requires the management of complex procedural processes to enable an end-user to program their kitchen devices according to their preferred behaviour and to allow them to visualize and track their cooking workflows.

Ventirozos et al. introduced meta-design in end-user programming/development (EUD), which refers to the environment where there can be end-users with varying levels of domain expertise (i.e., from novices to professional chefs) and programming/development skills (i.e., end-users to technology developers). They investigated how end-users can visualize workflows and how the semantic representations can work with widely used EUD paradigms, namely, Event Condition Action and the Block-based programming language. The paper seeks to compare these for the purpose of automatically responding to end-user actions, visualizing the state of the workflow, and supporting users to create/modify workflows. The differences are demonstrated through analysis of smart kitchen user requirements, where they inferred the main architectural requirements for IoT cooking workflows as variability and compositionality. Using user requirements, various scenarios were examined and workflow complexity and feasibility for each representation were analyzed. The analysis shows that Behaviour Trees tend to have more execution complexity while providing more transparency on how to recover from unprecedented circumstances. On the other hand, DX-MAN model has a higher parameter complexity while being more favourable due to its compositionality aspect and the ease of visualization. Evaluation takes place through 1) a quantitative comparison of execution, parameter, and memory complexity in terms of the number of leaf nodes, internal nodes, and so on, required to express various scenarios, and 2) a consideration of how each approach enables or limits the variability, and compositionality of the services.

Wrobel et al. [2] claim that human factors should be a primary concern for the design of MDE domain-specific languages and tools, since this would enable domain experts to efficiently as well as effectively comprehend, create, and update models. They report an ongoing study to develop a technical approach and research methodology for validating their claim in future empirical investigations. First, they describe the development of a language engineering framework that is based on the *Extended Layout Data Model* metamodeling approach. This framework supports the building of (i) graphical domain-specific modeling languages and (ii) graphical engineering systems. Second, they describe their plan to investigate three aspects:

- How the understanding of a model describing a technical system by a graphical domain-specific modeling language is increased by rendering domain-specific information in the concrete syntax.
- How users do rate building and editing models based on a graphical domain-specific modeling language compared to a general-purpose modeling language, and how the assessment differs between domain expert user, non-expert user, and language-expert.
- How expert users and scientists from the field of model-driven engineering evaluate the importance of domain-specific concrete syntax in graphical modeling languages.

As an implication, the authors claim that their work would support the development of UML/SysML tools that allow for more semantics in the concrete syntax of the language as well as better user interactions. This, according to the authors, allows the development of modeling tools that have a stronger domain reference.

Ragnarsson et al. [3] present a tool, called ModRec, to support designing and replicating empirical studies across multiple modeling environments, such as Papyrus and Eclipse Modeling Framework (EMF)-based tools. ModRec supports the specification of empirical studies as a series of tasks with option task duration. Moreover, it supports the execution of specific studies in Eclipse and a customizable as well as extensible instrumentation for logging activities in Papyrus and Eclipse EMF-based tools. To demonstrate their tool, the authors describe the use of ModRec for expressing and executing two published modeling empirical studies with different study designs and purposes. Finally, the authors plan to further develop ModRec in order to provide in-built support for randomized study designs. Moreover, they plan to evaluate the usability of ModRec and and create further listeners for existing EMF-based tools.

Michael et al. [4] describe a vision of using goals and goal modeling for human behavior assistance in generated systems. More specifically, they discuss how to improve the engineering process of assistive systems by using human behavior goals in the analysis, design, and run-time of a generated assistive system. To demonstrate their vision, they show its application by adding assisting functionalities to a real-world information system. The prototypical implementation shows the feasibility of the approach and provides preliminary insights into how it could enhance the ability of systems to assist end-users goals. In particular, the authors describe how goals should be formulated and what main goal concepts might be used in and together with system models. Moreover, they discuss how the main goal concepts can be translated to code within the generation process of assistive systems, and how goal modeling can be used during run-time of an assistive system. Finally, the authors call for a cooperation with RE researchers to further investigate the relationship between analysis models and system models to reduce the conceptual gap between the problem domain and software implementation domain.

Ramackers et al. [5] presented an Artificial Intelligence (AI) based development tool to provide automated support for synthesizing UML models from requirements text expressed in natural language. This approach transforms natural language into structural and dynamic UML models. The approach aims to simplify the process of analysis from written and spoken descriptions of the functionality of a system and a domain to an executable specification of that system. Ramackers et al. envision a "human-in-the-loop" approach through an interactive conversational component based on both the system under construction and corpora of external natural language texts and UML models. They have illustrated the approach through a tool prototype and an initial prototype of the P2P tool environment has been developed as a proof of concept. It is constructed using a three-tier technical architecture: 1) a web-based front-end where the tool user interface components execute; 2) an application server where NLP processing takes place; and 3) a back-end database tier used to store requirements texts, diagrams, UML models, and Python code snippets added for model scripting.

Ramackers et al. believe the unique aspects of their approach are: The ability to transform unstructured requirements text into UML specifications; 2) An advanced NLP approach that includes steps for text condensation, text classification and specification mapping that supports real world requirements texts; 3) Offering both batch and interactive mechanisms for synthesising a UML model, including visual modellers; 4) A data mining component that enables suggestions to the user; 5) Generation of an executable prototype which enables rapid user validation. This approach will enable domain experts and end-users to be more effectively involved in the requirements specification process.

Soria et al. [6] introduces a discussion about a potential study of the extra information that occurs during white board design, such as rationale and discussions. The tool is intended to serve the dual purpose of 1) supporting researchers to better understand the nature of software design at the whiteboard and 2) supporting future versions of the tool that will directly benefit software engineers by helping them to capture important aspects of their designs. To validate the approach, it presents a study design involving a qualitative analysis of recordings captured using the tool. The authors motivate the research, discuss what they learned in a pilot experiment with three teams of students, and then detail the future experiment that they intend to conduct with professionals.

Soria et al. describe the design of an experiment aimed at capturing important design bits (IDBs) that are developed during the course of a collaborative white board design session. A pilot study was used to develop the experimental protocols, including, notably, a coding scheme for the types of fragments that accumulate to compose an IDB. An electronic whiteboard tool (and accompanying cellphone app) was developed for this which included various mechanisms for capture of audio segments (eg the previous 60 seconds) which participants felt illustrated the occurrence of an IDB. The pilot suggested various changes to the experimental protocol for the larger study. Notable here is the replacement of face to face collaboration with remote collaboration reflecting the current pandemic setting, and an elimination of the cellphone app. The pilot also demonstrated some interesting features, such as a complete absence of explicit decisions, and a heavy emphasis on affirmations, the latter being ascribed to the use of audio for capturing design intent.

IV. HuFaMo Organizers

Hourieh Khalajzadeh (General Co-Chair, Web & Publicity Chair): Hourieh is a research fellow in the Human-centric Software Engineering (HumaniSE) lab at Monash University. Her research activities focus on human-centric software engineering, domain-specific visual languages and model-driven software development. https://research.monash.edu/en/persons/hourieh-khalajzadeh

Silvia Abrahão (General Co-Chair): Silvia is an Associate Professor at the Universitat Politecnica de Valencia in Spain. Her research interests focus on quality assurance in model-driven engineering, empirical assessment of modeling approaches, cloud architecture modeling and monitoring and the integration of usability/UX in software development. https://sabrahao.wixsite.com/dsic-upv

Miguel Goulão (General Co-Chair): Miguel is an Associate Professor of the Informatics Department of FCT/UNL and a researcher at the Software Systems group at NOVA LINCS. His research interests focus on using Empirical Software Engineering practices to promote software developer's productivity and experience by improving the usability of Modeling Languages, to empower developers and other stakeholders to more effectively use them. http://ctp.di.fct.unl.pt/~mgoul/

John Grundy (General Co-Chair): John Grundy is Australian Laureate Fellow and Professor of Software Engineering at Monash University where he leads the HumaniSE Lab. He has published extensively in software engineering tools, visual modeling languages, model-driven engineering, software architecture, and software security engineering. https://sites.google.com/site/johncgrundy/

Rodi Jolak (General Co-Chair): Rodi is a postdoctoral researcher in software engineering at the joint Department of Computer Science and Engineering of Chalmers University of Technology and Gothenburg University. His research activities focus on software engineering, software architectures, software design, human–computer interaction, and security. For more information see: http://www.rodijolak.com

Xavier Le Pallec (General Co-Chair): Xavier is an Assistant Professor at the Department of Computer Science and CRIStAL laboratory at the University of Lille. His research interests include: software modeling in practice, visualization and UI design in Model Driven Engineering. He coordinates a national research group studying relations between Software Engineering and Human Computer Interaction. https://pro.univ-lille.fr/en/who-am-i/

Emmanuel Renaux (General Co-Chair): Emmanuel is an associate professor of Computer Science and Network of IMT Lille Douai and associated researcher at CRIStAL laboratory at the University of Lille. His research interests focus on software engineering processes and software modeling in practice and more particularly, he studies NOUML (not only) sketches within the software development process.

Bran Selic (General Co-Chair) is an Adjunct Professor at the Faculty of IT at Monash University. He has published extensively on topics ranging from real-time systems, software architecture, operating systems, to model-driven engineering technologies and standards. He has over four decades of industrial experience with the design and development complex software systems in the cyber-physical space.

V. Program Committee

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