Preface

Welcome to the proceedings of the **ACM/IEEE 20th International Conference on Model Driven Engineering Languages and Systems (MODELS 2017)**. This year's conference was held in the vibrant and desert-like-temperature city of Austin, Texas. Austin is now the 11th largest city in the United States, and is one of four cities from Texas (the others are Houston, San Antonio, and Dallas) among the 11 largest. Austin is a center for high-tech industry, clean energy and power, data management, life sciences, and of course, education.

Technical Papers Summary

MODELS'17 received 121 total submissions, including: 85 Foundations Track papers (68 Technical, 9 New Ideas, and 8 Vision papers), and 36 Practice and Innovation papers. After review and discussion among the Program Committee and the Program Board, 24 papers were accepted to the Foundations Track (17 Technical, 3 New Ideas, and 4 Vision papers), for an acceptance rate of 28%. Among the 36 papers submitted to the Practice and Innovation Track, 9 papers were accepted overall for an acceptance rate of 25%.

Invited Talks

This year we sought to have most of our keynotes to highlight Texas industry, and were honored with a first-rate program of presenters. Our first keynote was from **Dr. Jeannie Falcon**, a Chief Engineer for Control and Simulation at **National Instruments (NI)**, Austin, Texas. NI is the leader in Virtual Instrumentation, pioneering LabVIEW, a systems engineering toolkit for applications that require test, measurement, and control of real-time hardware and software. Dr. Falcon's talk, "Facilitating Modeling and Simulation of Complex Systems Through Interoperable Software," discusses the challenges of designing software using models and simulation in heterogeneous hardware environments.

Our second keynote was by **Dr. Ira Baxter**, founder, CEO and CTO of **Semantic Designs**, Austin, Texas. Dr. Baxter is a pioneer in industrial applications of transformation systems. He is chief architect of the Design Maintenance System (DMS), a visionary and ambitious system, compiler, and infrastructure for the incremental development and maintenance of large applications. Dr. Baxter's talk, "Supporting Forward and Reverse Engineering with Multiple Types of Models," provided a unified view of how "models" and "code" can be treated consistently and how transforms between them can be harnessed for both forward and reverse engineering.

Our third keynote was by **Professor Adam Porter**, an honorary Texan at MODELS'17, Professor of Computer Science at the University of Maryland, and Executive and Scientific Director of the **Fraunhofer USA** Center for Experimental Software Engineering. His talk, "Enabling Applied Research and Technology Transfer with Models," explored the use and

importance of models and model-based technologies for applied research and technology transfer, and how models are used in day-to-day work at Fraunhofer.

We are grateful for Dr. Falcon, Dr. Baxter, and Professor Porter for their contributions as MODELS'17 keynoters.

In addition to keynotes, we were honored to have prominent industrial representatives in the **Model Based Systems Engineering (MBSE)** – a close relative of MDE. Darius Silingas is Chief Solutions Architect at **No Magic, Inc**. No Magic is a vendor of MagicDraw, the second oldest UML modeling platform and one of the first and most popular SysML modeling platforms. His talk, "Model Based Systems Engineering: State of the Practice," informed us about current industrial efforts on making MSBE standard practice using standardized tools.

Robert Baillargeon is Vice President of Solutions at **Sodius**, a vendor of MDWorkbench and MDAccess, which are leading solutions for integration of Systems and Software Engineering tools. His talk, "Advancing Adoption in Industry," presented experiences in advancing MBSE in industry, with a special focus on automotive applications. He explained why it is critical to understand the motivations of industry when the goal is universal adoption of MBSE techniques.

Additional Satellite and Main Conference Sessions

In addition to invited talks and technical sessions, MODELS'17 offered a full slate of 9 tutorials and 12 workshops, an Educators Symposium, a Doctoral Symposium, ACM Research Competition (sponsored by **Microsoft Research**), Tools and Demonstrations, Posters, and a lively panel on possible futures for MDE.

Artifact Evaluation

For the first time, MODELS offered an Artifact Evaluation option, led by Andrzej Wasowski (MODELS'18 General Chair) and Vadim Zaytsev. This was a small-scale experiment to try a procedure that will be taken full-scale next year.

Acknowledgements to Committees and Sponsors

This conference would not have been possible without the dedicated and hard-working support from its Organizing Committee and selection committees. A list of Organizing Committee and selection committee members for the satellite events are found on the MODELS'17 website (https://www.cs.utexas.edu/models2017). We thank them all for their expertise, time, and commitment across two years of planning and coordination.

Last, but certainly not least, MODELS'17 would not have been possible without its sponsors. (Please read the last sentence again for effect). We thank **National Instruments** (Platinum Sponsor), **Papyrus IC** and **Tata Consultancy Services** (Gold Sponsors), **No Magic** and

Sodius (Industry Sponsors), and especially the **Department of Computer Science** at the **University of Texas at Austin** (Institutional Sponsor) whose contribution to the financial, local organization, web support, and outreach was invaluable. Again, thank you all!

We hope that everyone who attended had an exciting, memorable, and intellectually stimulating time in Austin, and came away with ideas to advance the MODELS research and community in practical software development for many years to come.

August 2017

Don Batory
Jeff Gray
Vinay Kulkarni
Taylor Riché

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Keynotes

Facilitating Modeling and Simulation of Complex Systems Through Interoperable Software

Dr. Jeannie Falcon
National Instruments
Austin, Texas

Abstract. Incorporating models into the design, test, and monitoring processes of complex systems can reduce development costs and improve performance and reliability. However, developing appropriate models and calibrating these models with measurement data is often time consuming. The problems are magnified in cases of distributed systems and cyber-physical system. Additionally, real-time test and hardware-in-the-loop applications may require the partitioning of model components on heterogeneous targets with a combination of multi-core processors and field programmable gate arrays. There are various commercial and open-source software options available for developing models but multiple modeling tools may be required for a single application.

This talk will review current efforts to overcome these challenges in modeling and simulation. Several successful applications will be discussed as well. Research in this area is continuing and collaboration is a must.

Supporting Forward and Reverse Engineering with Multiple Types of Models

Dr. Ira Baxter
Semantic Designs
Austin, Texas

Abstract. Many model-based tools work with single models, which capture some abstraction of a target software system of interest, with intent to convert the abstract description into a runnable computer program somehow. These tools usually provide some type of model-to-model transforms to carry out operations appropriate for the abstraction level of "the" model, and model-to-text transforms to generate low-level program source code. The model-to-model and model-to-text transforms are treated differently; one difference is that model-to-model transforms (may) compose, but model-to-text transforms by definition do not compose.

We have found it practical to mix high level models of programs with low-level models of source code, using domain-specific notations for each, and applying composable transformations (both reifying and abstracting) to both.

This talk will provide an intuitive unified view of how "models" and "code" can be treated consistently, and how transforms between them may be harnessed for both forward and reverse engineering.

A practical version of such a tool must be able to (meta)model a variety of models and source code, and allow specification and execution of transformations across these.

We will describe an effective tool for reverse engineering "assembly code" for running large-scale chemical plants back to abstract process control models, and then forward engineer those models to a completely different industrial control language, preserving the critical elements of factory control. This realizes the vision of (ADM/MDA) of "architecture-driven modeling of legacy applications into reifiable models. The implementation uses a combination of abstract syntax trees, data-flow graphs, and what amounts to graph-grammars, and mixes the analysis and transformation of these. Special support for reverse engineering low level code is provided by data flow pattern graphs. This reverse/forward engineering tool is realized using a commercial program transformation (DMS).

The resulting tool is being used by a Fortune 100 company to re-engineer the process control code for roughly 1000 factories.

Enabling Applied Research and Technology Transfer with Models

Professor Adam Porter
University of Maryland
Fraunhofer USA Center
College Park, Maryland

Abstract. For the first 25 years of my career, I worked primarily in the University setting, focusing on education and basic research. Recently, I took over as the Executive Director of the Fraunhofer USA Center for Experimental Software Engineering in College Park, MD. Fraunhofer is a global organization with a mission to do applied research and technology transfer that gets technology into the hands of industrial companies so they can be successful.

To keep this Center aligned with the overall Fraunhofer mission, I have had to look hard at how basic research gets successfully transferred into practice. One result of this is my belief that models and model-based technologies are particularly well-suited to the goals of applied research and technology transfer. Just a few reasons for this include that models addresses key industrial concerns such as the need to express and manage complexity, models enable a wide variety of powerful, automatable analyses, useful at multiple stages of the system development lifecycle, and models act as a common language facilitating the interaction of domain and systems experts.

In this talk I'll give a very brief overview of the Fraunhofer organization. I will discuss how models help us engage effectively with government and industrial clients, and I will provide a number of examples of how we use models in our day to day work.

Table of Contents

The following papers comprise the main technical presentations at MODELS'17. The presentations were organized into 13 categories. Three separate tracks are mixed among the research categories: Foundations Track (FT), Practice & Innovation (P&I), and SoSyM First (SoSyM). There were also three sub-categories of Foundations papers: Technical (FT), New Ideas (FT-NI), and Vision (FT-V) papers. The tracks are indicated at the end of the author list for each paper.

Partial Evaluation of OCL Expressions
Bastian Ulke, Friedrich Steimann, Ralf Lämmel (FT)

DSLs

Reusable Specification Templates for Defining Dynamic Semantics of DSLs
Ulyana Tikhonova (SoSyM)

Active Domain-Specific Languages: making every mobile user a modeller
Diego Vaquero-Melchor, Javier Palomares, Esther Guerra, Juan de Lara (FT-V)

Experiences with Teaching MPS in Industry -- Towards Bringing Domain Specific Languages Closer to Practitioners
Daniel Ratiu, Vaclav Pech, Kolja Dummann (P&I)

Product Lines

Software Product Lines with Design Choices: Reasoning about Variability and Design Uncertainty
Michalis Famelis, Julia Rubin, Krzysztof Czarnecki, Rick Salay, Marsha Chechik (FT-V)

Transformations of Product Lines: A Generalizing Framework based on Category Theory
Gabriele Taentzer, Rick Salay, Daniel Strüber, Marsha Chechik (FT)

Revisiting Visitors for Modular Extension of Executable DSMLs
Manuel Leduc, Thomas Degueule, Benoit Combemale, Tijs van der Storm, Olivier Barais (FT)

Validation & Verification

From Secure Business Process Modeling to Design-Level Security Verification
Qusai Ramadan, Mattia Salnitri, Daniel Strüber, Jan Jürjens, Paolo Giorgini (FT)

Why Is My Component and Connector Views Specification Unsatisfiable?
Shahar Maoz, Nitzan Pomerantz, Jan Oliver Ringert, Rafi Shalom (FT)

Tool Support for Live Formal Verification
Vincent Aravantinos, Sudeep Kanav (P&I)

Modeling in Industry

Model-driven Development of Safety Architectures
Ewen Denney, Ganesh Pai, Iain Whiteside (P&I)

Component and Connector Views in Practice: An Experience Report
Vincent Bertram, Shahar Maoz, Jan Oliver Ringert, Bernhard Rumpe, Michael von Wenckstern (P&I)

Synthesis and Exploration of Multi-level, Multi-perspective Architectures of Automotive Embedded Systems
Jordan Ross, Alexandr Murashkin, Jia Hui Liang, Michal Antkiewicz, Krzysztof Czarnecki (SoSyM)

New Frontiers

Managing Design-Time Uncertainty
Michalis Famelis, Marsha Chechik (SoSyM)

The Next Evolution of MDE: a Seamless Integration of Machine Learning into Domain Modeling
Thomas Hartmann, Assaad Moawad, Francois Fouquet, Yves Traon (SoSyM)

Raising Time Awareness in Model-Driven Engineering
Amine Benelallam, Thomas Hartmann, Ludovic Mouline, François Fouquet, Johann Bourcier, Olivier Barais, Yves Le Traon (FT-V)

Co-evolution & Collaboration

Co-evolution of Meta-Modeling Syntax and Informal Semantics in Domain-Specific Modeling Environments - A Case Study of AUTOSAR
Darko Durisic, Corrado Motta, Miroslaw Staron, Matthias Tichy (FT)

Property-based Locking in Collaborative Modeling
Csaba Debreceni, Gábor Bergmann, István Ráth, Dániel Varró (FT)

Heuristic-based Recommendation for Metamodel-OCL Coevolution
Edouard Batot, Wael Kessentini, Houari Sahraoui, Michalis Famelis (FT)

Modeling Infrastructure

Ecoreification: Making Arbitrary Java Code Accessible to Metamodel-Based Tools
Heiko Klare, Erik Burger, Max Kramer, Michael Langhammer, Timur Saglam, Ralf Reussner (FT-NI)

User Experience for Model-Driven Engineering: Challenges and Future Directions
Silvia Abrahão, Francis Bordeleau, Betty Cheng, Sahar Kokaly, Richard Paige, Harald Störrle, Jon Whittle (FT-V)

Bridging Proprietary Modelling and Open-Source Model Management Tools: The Case of PTC Integrity Modeller and Epsilon
Athanasios Zolotas, Horacio Hoyos Rodriguez, Dimitris Kolovos, Richard Paige, Stuart Hutchesson (P&I)

Modeling & Systems Engineering

Ontology-Based Pattern for System Engineering
Dominique Ernadote (P&I)

DREAMS Toolchain: Model-Driven Engineering of Mixed-Criticality Systems
Simon Barner, Alexander Diewald, Jörn Migge, Ali Syed, Gerhard Fohler, Madeleine Faugère, Daniel Gracia Pérez (P&I)

Bringing DSE to Life: Exploring the Design Space of an Industrial Automotive Use Case
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A Systematic Mapping Study on Modeling for Industry 4.0
Andreas Wortmann, Benoit Combemale, Olivier Barais (FT)

An Empirical Evaluation of the Maturity of the Eclipse Modeling Ecosystem
Javier Luis Canovas Izquierdo, Valerio Cosentino, Jordi Cabot (FT)

A Survey of Tool Use in Modeling Education
Luciane Telinski Wiedermann Agner, Timothy C. Lethbridge (P&I)

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Symbolic Execution for Realizability-Checking of Scenario-based Specifications
Joel Greenyer, Timo Gutjahr (FT)

A Model-Driven Approach to Trace Checking of Pattern-based Temporal Properties
Wei Dou, Domenico Bianculli, Lionel Briand (FT)

Removal of Redundant Elements within UML Activity Diagrams
Martin Beckmann, Vanessa Nicole Michalke, Andreas Vogelsang, Aaron Schlutter (FT)