Buchbesprechung
"Collaborative and Distributed Chemical Engineering From Understanding to Substantial Design Process Support" Manfred Nagl, Wolfgang Marquardt (Eds.)

Jürgen Ebert
Institut für Softwaretechnik, Universität Koblenz-Landau
D-56070 Koblenz, Universitätsstr. 1
email: ebert@uni-koblenz.de

April 2009

1 Introduction

Final reports of large interdisciplinary research projects are hard to read and contain too much and too heterogeneous content to be of real value for individual readers. On the other hand, precious and practically immensely useful information is collected in such projects.

This comprehensive report on the DFG funded Collaborative Research Center (CRC, Sonderforschungsbereich) „Information Technology Support for Collaborative and Distributed Design Processes in Chemical Engineering" (IMPROVE) carried out at the RWTH Aachen, Germany, gives a thorough report on such a project. This report is written from an applied software engineering view and focusses on modeling and tool integration aspects.

IMPROVE was run as a joint project of seven different groups in Chemical Engineering and in Computer Science. With an overall funding of about 11 million euros and a basic runtime of 9 years from 1997-2006, which is being continued by a 3-year DFG funded Transfer Center (TC, Transferbereich), IMPROVE has produced a plethora of results in applied computer science within the area of engineering support.

This report [**?**] is published in the series Lecture Notes in Computer Science, which indicates its high relevance for the computer science community.

2 The IMPROVE project

The book focusses on understanding, formalizing, evaluating, and improving *design processes* in chemical engineering, especially the processes of conceptual design and basic engineering. The objective of a such a process is the development of a manufacturing process to produce a material chemical product.

The activities of these design processes are studied in the context of a collaborative and geographically distributed team of multi-disciplinary experts. A concrete design process, namely the design of a chemical plant producing Polyamid-6 (PA-6, used for the production of fibers) is used as the reference scenario.

Such design processes usually require different types of mathematical models, which are implemented in different types of modeling environments, and several software tools, which are completely different in nature concerning the services they provide.

The progress achieved by IMPROVE is the derivation of a formal process model (including a uniform product model) to formalize the design processes and their products and a mature approach for tool integration, which integrates existing external tools and new internal ones into an interoperable tool landscape in the form of an integrated environment in a *bottom up* manner.

3 Contents

The book is composed along the structure of the IMPROVE-project and describes the status at the end of the CRC-period supplying one section per subproject and some additional material.

Chapter 1 contains a compact overview on the results achieved from the viewpoint of the consortium. It contains an overview on the model-driven approach for tool integration developed in IMPROVE and illustrates the demonstrator exemplifying the tight integration of external and internal tools.

The various product and process models for the application domain of chemical process engineering are presented at first in *chapter 2*. Product data models describe the chemical plant and the chemical substances involved. Document models capture the different kinds of documents, their interrelation and contents, and their dynamic behavior over time. Work process models cover the design process for a plant, and finally decision models represent the design rationale. Each of the four model types is described in detail, including meta-descriptions and examples. They are integrated to one comprehensive chemical engineering domain model, called C^2EDM for short.

These modeling results from the application domain are supplemented by new methodological results from computer science in *chapter 3*: (1) To support the inherently

creative character of the chemical design process, a knowledge engineering solution was developed to capture and reuse experience during the design process in a flowsheet-centered design support environment supporting the reuse of process chunks and process traces. (2) To keep the various documents in an overall consistent state on a fine-grained level, incremental integrator tools were developed that assist the developers in consistency maintenance. They constitute a general framework, which is based on integration rules using the triple-graph-grammar formalism. (3) To support the close cooperation between the different working groups in the design process including people from industry, an integrated communication platform was developed, which improved the communication by including multimedia and immersive virtual reality tools and protocol mechanisms. This development leads to an effective form of cooperation between different groups. (4) To manage the inherently difficult design processes in chemical engineering as a whole, an adaptable process management system was developed which supports process definition, coordination and evolution for design teams in industrial practice on the managerial level and on the technical level.

Chapter 4 describes the infrastructure developed to smoothly support the newly developed integrated environment: (1) The distributed storage and routing of information flows in cooperative design processes is supported and optimized by a so-called process data warehouse concept to manage organizational knowledge. It is based on a metadata repository providing a querying facility and thus keeping and supplying experience information. (2) The bottom-up coupling of the heterogenous external and internal tools is supported by a Corba-based service management platform providing transparent, efficient, and fault-tolerant access to services on the technical level.

These three main chapters concerning the technical results are accompanied by two chapters collecting several additional results (*chapters 5 and 6*), including a work flow modeling system developed to model industrial design processes, a transformation technique for semi-formal models into formal simulatable workflow models, an environment that facilitates modeling and simulation across the boundaries of tools (using different mathematical models and data structures), a description of the different dimensions of integration inside the plastics processing domain, examples of synergistic integration, notes to usability engineering, and remarks on tool integration with emphasis on software architecture and model-driven development.

Finally, *chapter 7* reports on the transfer to practice of the results produced of IMPROVE in the ongoing TC by 8 different transfer storiesn and *chapter 8* summarizes the project from the academic viewpoint, gives reports on the lessons learnt, and cites open problems.

4 Conclusion

All in all, this books gives a comprehensive description of an extensive endeavor in applied software engineering with an emphasis on modeling and tool integration. The results are described in detail including the rationales behind that work. So the achievements seem to be generalizable and transferable to other areas, as well.

This book is a valuable source of knowledge and experience for software engineers starting work in tool support for engineering applications in general.