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GUEST EDITORIAL

Special Issue: Configuration Design

TIMOTHY DARR,[1] MARK KLEIN,[2] AND DEBORAH L. McGUINNESS[3]

[1]Trilogy Development Group, 6034 West Courtyard Drive, Austin, TX 78730, U.S.A.
[2]Center for Coordination Science, MIT Sloan School of Management, One Amherst Street E40-169, Cambridge, MA 02139, U.S.A.
[3]AT&T Labs—Research, 180 Park Ave., Florham Park, NJ 07932, U.S.A.

In configuration design parts are selected and connected to meet customer specifications and engineering and physical constraints. Specifications include preferences (e.g., "prefer lower cost to higher performance, all things being equal"), bounds on various resources (e.g., "the computer should have four PCI slots"), and other information to customize a configuration. Constraints typically arise from exogenous concerns, such as the available parts, the way parts can interact, and the manufacturing plant.

Configuration design was an early success in applying artificial intelligence (AI) techniques, specifically expert or rule-based systems, to practical problems. Among the most famous example is the R1 system for configuring computers and the accompanying XSEL, which were used at Digital Equipment Corporation (McDermott, 1980, 1981). In the early to mid-1980s many systems and techniques were developed in the research community to solve a variety of configuration-design problems. After this early activity, a plateau was reached in the research community.

Because configuration is fundamentally a design activity, research has always been closely aligned with practical applications. It is not surprising, then, that renewed interest in configuration-design research is driven in part by industrial need. In addition, newer techniques have been developed over the past 15 years that have advantages, such as improved knowledge representation, computational performance, and adaptation to new technologies (e.g., the World Wide Web).

In many industries today, there does not exist a "standard" product offering, but products are created specifically for a customer's unique needs, known variously as *pick-to-order*, *assemble-to-order*, *configure-to-order*, and *engineer-to-order*. Examples include computer and telecommunication equipment, financial services, and even footwear. This type of customization for even the simplest products requires a configuration system to guarantee product accuracy and completeness. In addition, configuration has a direct affect on pricing, the length of the sales cycle, and inventory (DeSisto, 1997). Thus, configuration is a core element of "Technology-Enabled Selling." According to the Gartner Group, this market has experienced 35% annual growth since 1995, and will reach $3.9 billion in software licenses by 2000 (Goltermann, 1997). Companies that do not address these elements will be at a severe competitive disadvantage.

To review the history of configuration design from a research perspective, we have asked Dr. David Brown of WPI to submit a position paper. In this paper, entitled *Defining Configuring*, Prof. Brown revisits the classic definition of configuration design by Mittal and Frayman (1989), and concludes that there is much left unsaid.

To look ahead to future research directions that may impact commercial applications, we have asked Dr. David Franke, chief architect at Trilogy Development Group, to draw on his experiences to identify future avenues of research that will have a direct impact on business.

1. THE GENERAL THEMES OF THIS ISSUE

Our aim in this special issue is to motivate renewed interest in configuration-design research and to show a sample of the state-of-the-art. Based on the submissions for this special issue, we are encouraged by the variety of techniques currently being applied to configuration problems.

In the paper *Towards a General Ontology of Configuration*, Timo Soininen, Juha Tiihonen, Tomi Männistö, and Reijo Sulonen attempt to unify configuration terminology as a step toward a general ontology of configuration, which is needed to reuse and share configuration knowledge. This is an important area of research for solving large-scale configuration problems using heterogeneous knowledge sources.

Two papers are included from the constraint-based framework. In the first paper, *A Classification and Constraint Based Framework for Configuration*, Daniel Mailharro presents a framework that models configuration problems using clasification and constraint-satisfaction problem (CSP) techniques. Classification techniques are used to structure domain knowledge to take advantage of inheritance to increase maintainability. CSP concepts are used to represent constraints, identify propagation and solution algorithms, and reason about partial knowledge.

In the second constraint-based paper, *Dynamic, Constraint-Based Configuration of Large Technical Systems*, Markus Stumptner, Gerhard Friedrich, and Alois Haselböck extend the standard CSP model. The Generative CSP provides simple semantics for reasoning about configuration problems, is flexible enough to use existing CSP techniques, and allows reasoning about problems with large and variable number of components in the solution, or both.

In the paper *Proof Planning for Maintainable Configuration Systems*, Helen Lowe, Michal Pechocek, and Alan Bundy apply the proof-planning technique to solving configuration problems. This technique improves maintainability, as well as providing a clear separation of the different types of knowledge needed to solve configuration problems.

The paper *Conceptual Modelling for Configuration: A Description Logic-based Approach*, by Deborah L. McGuinness and Jon R. Wright, presents a description logic-based approach to modelling configuration problems. The authors rely on 9 years of experience with deployed configurators to conclude that this approach provides the following benefits: object-oriented modelling of domain elements, incremental addition of specifications, reasoning with partial or incomplete knowledge, consistency detection and maintenance, declarative knowledge encoding, and retraction and truth maintenance.

Finally, the special issue includes two *practicum* papers that describe specific systems. In the paper *Web-based Configuration Assistants*, Giuseppe Attardi, Antonio Cisternino, and Maria Simi describe a framework for building web-based applications for solving process-oriented configuration problems where the user is guided through the configuration process. An application for configuring a plan of study illustrates this approach. In the paper *SyDeR—System Design for Reusability*, Frank Feldkamp, Michael Heinrich, and Klaus Dieter Meyer-Gramann describe a system that supports interactive configuration design of complex products. This system includes structural modelling, a library of solutions, and constraint techniques to propagate design decisions.

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