Artificial Intelligence for Engineering Design, Analysis and Manufacturing (2006), *20*, 295. Printed in the USA.

DOI: 10.1017/S0890060406060215

GUEST EDITORIAL

Special Issue: Constraints and design

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Constraint processing has emerged as an extremely expressive and powerful paradigm in which to model, solve, and reason about many complex problems. Over the past four decades advances in both the fundamental aspects of constraint processing and practical applications of constraints have contributed to making it one of the most promising of artificial intelligence technologies.

In product development and design, constraints arise in many forms. The functional description of an artifact defines a set of constraints, as does the physical realization of that functionality. The production processes that will be used to manufacture the artifact can constrain the materials and dimensions that the designer can select. Preferences can be represented as constraints so that optimization techniques can be employed, as well as forming a basis for negotiation when conflicts arise during the design process. In many situations constraints emerge during design, motivating the need for techniques that support the acquisition and discovery of constraints, as well as algorithms for dynamic constraint satisfaction. Finally, designers often wish to have explained to them why particular design options are not available to them or how to overcome blind alleys. Techniques from the fields of diagnosis, as well as approaches to visualization and explanation, are important here. More generally, a broad literature exists on the use of constraints in engineering design. Among the most common themes are applications of constraints to the major phases of design such as conceptual, embodiment, and detailed design; the use of constraints for integrated product development, concurrent engineering, and Design for X; the role of constraints in product configuration; and constraint-based systems for design critiquing, design evaluation, and design-rule checking. Although the study of constraints has been maturing over the past four decades, many opportunities remain to hybridize constraint processing with other techniques from the fields of artificial intelligence and engineering to develop sophisticated tools to support design.

Each paper submitted to this Special Issue underwent a rigorous review process. Each submission was anonymously reviewed by three expert reviewers, and a selection for publication was made on the basis of those reviews. The papers that appear in this Special Issue demonstrate synergies between constraints and technique from such diverse fields as machine learning, optimization, algebra, engineering, human–computer interaction, and intelligent user interfaces in a variety of engineering domains. Lallouet and Legtchenko show how partially defined constraints can be extended using classifier learning in order to complete their specification. They also present an approach to learning how to propagate such constraints. Hicks et al. show how constraints can be used to assist in the design process of high-speed machinery. Yan and Sawada show how an algebraic approach to reasoning about constraints can be used to provide designers with a deeper appreciation of the complexities of design problems. Gurnani et al. present a constraint-based tool for reasoning about the preliminary stages of design using techniques from the field of multi-objective optimization. Lourenço et al. present an approach to geometric constraint solving for feature manipulation. Finally, Deshpande and Rinderle show how dominance among constraints can be used to simplify design problems and help designers gain deeper insights into how to approach the design process.

I express my deepest thanks to both the authors of the papers submitted to this Special Issue, as well as the reviewers who provided such comprehensive and helpful reviews. It is my hope that readers of this issue will enjoy the papers that were finally selected. I also extend a very special thanks to the Editor-in-Chief of *AIEDAM*, David C. Brown, for making this issue possible. Behind the scenes he is supported by an excellent editorial manager from Cambridge University Press, Nancy L. BriggsShearer, whose assistance in producing this issue I greatly appreciated and acknowledge.

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