

## A Review of Research in Mechanical Engineering Design. Part I: Descriptive, Prescriptive, and Computer-Based Models of Design Processes

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**Abstract.** This is the first of a two-part paper summarizing and reviewing research in mechanical engineering design theory and methodology. Part I includes: 1) descriptive models; 2) prescriptive models; and 3) computer-based models of design processes. Part II, which will appear in the next issue of this journal, will include: 4) languages, representations, and environments for design; 5) analysis in support of design; and 6) design for manufacture and the life-cycle. For each major area, we discuss the current topics of research and the state of the art, emphasizing recent significant advances. We also discuss the important open research issues in each area. The six categories are certainly not mutually exclusive nor even collectively exhaustive; however, some organization is necessary, and these categories have been effective in making sense of a body of research that is expanding rapidly in many exciting and promising directions. The mechanical engineering design research community has made major advances over the last few years. The research community in mechanical engineering design has made significant progress not only in advancing our knowledge of design, but also in clarifying the research methods necessary to study design. Great progress is being made toward a better understanding of design, and hence toward better design tools.

### 1 Introduction

This paper, the first in a series of reviews that will be published in *Research in Engineering Design*, summarizes and reviews the state of research in engineering design theory and methodology, concentrating on mechanical engineering design. Subsequent reviews will concentrate on other areas of engineering design or on special sub-topics. The goal of the series is to inform the community at large of advances in the developments in engineering design research. We also hope that it will enable

researchers to place their work in context and thus guide continuing work. The series of papers is also intended to be an efficient starting place for those who wish to become familiar with the engineering design literature relevant to their interests.

#### 1.1 Scope

There are, of necessity, limits to the nature and scope of this review. First, the review is not intended to be a substitute for reading complete papers; it is intended only as a brief summary of, and guide to, the literature. Although we have made every reasonable effort to be complete, omissions are inevitable. There can also be errors of commission caused by misinterpretation or lack of full understanding on our part of papers included in the review. We apologize to both readers and researchers for these errors.

The scope is limited in several ways. We intend only to include research in engineering design, and then only that portion of engineering design broadly called "mechanical," which includes products, machines, structures, and the like. Research in geometric modeling, architectural design, manufacturing, expert systems, and optimization are included only when the research is directly relevant to design of mechanical systems. We have also not attempted to cover the many new, commercial computer-aided design (CAD) systems which have begun to incorporate the research ideas discussed in this review.

The research discussed in this review paper has been conducted primarily in the United States. Work outside the U.S. has not been excluded, but is not covered systematically. Finally, research on mechanical design in very specific technical domains (e.g., mechanisms and heat exchangers) is not covered unless it is clearly extendible to other mechanical design domains.

\* *Reprint requests:* Robotics Institute, Carnegie Mellon University, Pittsburgh, PA 15213, USA.

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*Research and Development in Mechanical Engineering* Predrag Dašić, 2015-11-20 Selected peer reviewed papers from the 14th International Conference on Research and Development in Mechanical Industry RaDMI 2014 Topola Serbia 18-21 September 2014

**Journal of the American Society of Mechanical Engineers** American Society of Mechanical Engineers, 1918

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*Engineering*, 1911

Proceedings - Institution of Mechanical Engineers Institution of Mechanical Engineers (Great Britain), 1920

Machinery, 1919

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board members present lee bleuel ric bloohm tom jaster kristen mielke linda pickart rick welak bob wondra edward feucht  
mark scharschmidt board members absent administration present

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education called the meeting to order at 6 00p m the pledge of allegiance was recited motion by mr feucht second by mr  
wondra to approve the consent agenda motion carried 9 aye

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web carrefour is a french group and a leading global retailer our main assets staying as close as possible to our customers in the various countries and territories in which we operate we continuously adapt our retail formats and channels to suit their needs we have over 321 000 employees throughout the world

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web carrefour sa overview carrefour sa carrefour is a global consumer goods retailer the company operates through a network of supermarkets convenience stores hypermarkets discount stores and cash and carry stores it operates multi format and omnichannel retail platforms and retails merchandise through e commerce websites

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web mar 6 2019 history and today of carrefour supermarkets carrefour began its operations with a supermarket in adana in 1996 after the agreement made between carrefour and sabanci the company has grown over the years by buying various market chains at 2018 they reached over 614 supermarkets at 53 provinces in turkey their

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web carrefour french pronunciation kɑʁfʁɔ̃ i is a french multinational retail and wholesaling corporation headquartered in massy france the eighth largest retailer in the world by revenue it operates a chain of hypermarkets groceries stores and convenience stores which as of december 2021 comprises 13 894 stores in over 30 countries 3

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web 3 developing a responsible offer and involving consumers in implementing the food transition carrefour wants to inform engage and involve customers in order to make them stakeholders in the food transition carrefour highlights the food transition in stores through the deployment of its global communications programme act for food