

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.

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Proceedings of Mechanical Engineering Research Day 2017 Mohd Fadzli Bin Abdollah, Tee Boon Tuan, Mohd Azli Salim, Mohd Zaid Akop, Rainah Ismail, Haslinda Musa, 2017-05-29 This e book is a compilation of papers presented at the Mechanical Engineering Research Day 2017 MERD 17 Melaka Malaysia on 30 March 2017 The Academic Discourse of Mechanical Engineering Thi Ngoc Phuong Le, Minh Man Pham, Michael Barlow, 2023-03-15 This volume examines rhetorical conventions employed in mechanical engineering research to understand the knowledge making principles of the discipline as well as their expression within the research article In particular the study analyses the organisational patterns of mechanical engineering research articles using Swales s conceptualisation of moves and steps In addition the research identifies the phraseology associated with specific moves and steps The study draws on a corpus of 120 mechanical engineering research articles equally distributed across two sub disciplines mechanical systems and thermal fluids engineering three research traditions experimental theoretical and mixed methods and two publication periods 2002 2006 and 2012 2016 It adopts an integrated methodology intertwining various approaches and perspectives including corpus linguistics move analysis discourse analysis and interviews to address two main strands of research enquiry i What are the properties of the rhetorical structures in terms of range frequency and length for each section of mechanical engineering research articles ii What effect does sub discipline research tradition and publication date have on the rhetorical structure of research articles *Proceedings of Mechanical Engineering Research Day 2022* Amrik Singh Phuman Singh , Mohd Fadzli Bin Abdollah , Hilmi Amiruddin , Mastura Mohammad Taha, 2022-08-31 This open access e proceeding is a compilation of 134 articles presented at the 8th Mechanical Engineering Research Day MERD 22 Kampus Teknologi UTeM Melaka Malaysia on 13 July 2022 *Proceedings of Mechanical Engineering Research Day 2019* Mohd Fadzli Bin Abdollah, 2019-08-05 This e book is a compilation of papers presented at the 6th Mechanical Engineering Research Day MERD 19 Kampus Teknologi UTeM Melaka Malaysia on 31 July 2019 *Proceedings of Mechanical Engineering Research Day 2016* Mohd Fadzli Bin Abdollah, Mohd Azli Bin Salim, Tee Boon Tuan, 2016-03-31 This e book is a compilation of papers presented at the Mechanical Engineering Research Day 2016 MERD 16 Melaka Malaysia on 31 March 2016 **Challenges and Opportunities in Industrial and Mechanical Engineering: A Progressive Research Outlook** S M Pandey, Ambrish Maurya, Chetan Kumar Hirwani, Om Ji Shukla, 2024-06-24 Present time Industry 4 0 is the need of all industries because it connects industries to AI high productivity safety and flexibility ensures the 100% utilization of resources across diverse manufacturing systems and could accelerate normal manufacturing systems to advanced manufacturing systems by using robotics additive manufacturing and many more In this book the collection of selected papers is constituted from the International Conference on Progressive Research in Industrial Mechanical Engineering PRIME 2021 which was at the National Institute of Technology NIT Patna India from August 5 to 7 2021 This conference brings together all academic people industry experts

and researchers from India as well as abroad for involving thoughts on the needs challenges new technology opportunities threats in the current transformational field of aspire This book deliberates on several elements and their relevance to hard core areas of industrial and mechanical engineering including design engineering production engineering industrial engineering automobile engineering thermal and fluid engineering mechatronics control robotics interdisciplinary and many new emerging topics that keep potential in several areas of applications This book focuses on providing versatile knowledge of cutting edge practices to all readers helping to develop a clear vision toward Industry 4.0 robotics automation and additive manufacturing in this demanding and evolving time The book will be a treasured reference for students researchers and professionals interested in mechanical engineering and allied fields Mechanical Engineering ,1919 **Journal of the American Society of Mechanical Engineers** American Society of Mechanical Engineers,1918 *Benchmarking the Competitiveness of the United States in Mechanical Engineering Basic Research* National Research Council,Division on Earth and Life Studies,Board on Chemical Sciences and Technology,Panel on Benchmarking the Research Competitiveness of the United States in Mechanical Engineering,2008-12-14 Mechanical engineering is critical to the design manufacture and operation of small and large mechanical systems throughout the U S economy This book highlights the main findings of a benchmarking exercise to rate the standing of U S mechanical engineering basic research relative to other regions or countries The book includes key factors that influence U S performance in mechanical engineering research and near and longer term projections of research leadership U S leadership in mechanical engineering basic research overall will continue to be strong Contributions of U S mechanical engineers to journal articles will increase but so will the contributions from other growing economies such as China and India At the same time the supply of U S mechanical engineers is in jeopardy because of declines in the number of U S citizens obtaining advanced degrees and uncertain prospects for continuing to attract foreign students U S funding of mechanical engineering basic research and infrastructure will remain level with strong leadership in emerging areas **The Mechanical Engineer** William Henry Fowler,1911

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