

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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Recent Advances in Mechanical Engineering Premananda Pradhan, Binayak Pattanayak, Harish Chandra Das, Pinakeswar Mahanta, 2022-06-03 This book presents select proceedings of the International Conference on Recent Advances in Mechanical Engineering Research and Development ICRAMERD 21 It covers the latest research trends in various branches of mechanical engineering The topics covered include materials engineering industrial system engineering manufacturing systems engineering automotive engineering thermal systems smart composite materials manufacturing processes industrial automation and energy system The book will be a valuable reference for beginners researchers engineers and industry professionals working in the various fields of mechanical engineering *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 **Mechanical Engineering**, 1919 Handbook of Research on Advancements in Manufacturing, Materials, and Mechanical Engineering Burstein, Leonid, 2020-09-18 Production new materials development and mechanics are the central subjects of modern industry and advanced science With a very broad reach across several different disciplines selecting the most forward thinking research to review can be a hefty task especially for study in niche applications that receive little coverage For those subjects collecting the research available is of utmost importance The Handbook of Research on Advancements in Manufacturing Materials and Mechanical Engineering is an essential reference source that examines emerging obstacles in these fields of engineering and the methods and tools used to find solutions Featuring coverage of a broad range of topics including fabricating procedures automated control and material selection this book is ideally designed for academics tribology and materials researchers mechanical physics and materials engineers professionals in related industries scientists and students A Guide to the Scientific and Technical Literature of Eastern Europe Battelle Memorial Institute, National Science Foundation (U.S.), 1963 *Advances in Applied Mechanical Engineering* Hari Kumar

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Mechatronics Ram, Mangey,Davim, J. Paulo,2016-10-25 The application of mathematical concepts has proven to be beneficial within a number of different industries In particular these concepts have created significant developments in the engineering field Mathematical Concepts and Applications in Mechanical Engineering and Mechatronics is an authoritative reference source for the latest scholarly research on the use of applied mathematics to enhance the current trends and productivity in mechanical engineering Highlighting theoretical foundations real world cases and future directions this book is ideally designed for researchers practitioners professionals and students of mechatronics and mechanical engineering *Emerging*

Trends in Mechanical Engineering L. M. Das,Naveen Kumar,Rohit Singh Lather,Pramod Bhatia,2020-12-11 This book consists of select proceedings of the International Conference on Emerging Trends in Mechanical and Industrial Engineering ICETMIE 2019 It covers current trends in thermal design industrial production and other sub disciplines of mechanical engineering This volume focuses on different areas of design engineering including computational mechanics computational fluid dynamics finite elements in modelling simulation analysis and design kinematics and dynamics of rigid bodies micro and nano mechanics solid mechanics and structural mechanics vibration and acoustics applied mechanics and biomechanics It also covers various topics from thermal engineering including refrigeration plants heat exchangers heat pumps and heat pipes combined heat and power and advanced alternative cycles polygeneration combustion processes heat transfer solar cells solar thermal power plants and the integration of renewable energy with conventional processes This book will be useful for students researchers as well as professionals working in the area of mechanical engineering especially thermal engineering and engineering design and other allied areas **Engineering and Contracting** ,1918 **MECHANICAL**

ENGINEERING, ENERGY SYSTEMS AND SUSTAINABLE DEVELOPMENT -Volume I Konstantin V. Frolov,Oleg N. Favorsky,R.A. Chaplin and Christos Frangopoulos,2009-04-15 Mechanical Engineering Energy Systems and Sustainable Development theme is a component of Encyclopedia of Physical Sciences Engineering and Technology Resources in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias The Theme on Mechanical Engineering Energy Systems and Sustainable Development with contributions from distinguished experts in the field discusses mechanical engineering the generation and application of heat and mechanical power and the design production and use of machines and tools These five volumes are aimed at the following five major target audiences University and College Students Educators Professional Practitioners Research Personnel and Policy Analysts Managers and Decision Makers NGOs and GOs *Professional Engineer* ,1920 *Engineering & Contracting* ,1919 **Advances in Clean Energy** Anand Ramanathan,Babu Dharmalingam,Vinoth Thangarasu,2020-10-22 Advances in Clean Energy Production and Application supports sustainable clean energy technology and green fuel for clean combustion by reviewing the pros and cons of currently available technologies specifically for biodiesel production from biomass sources recent fuel modification strategy low temperature combustion technology including other biofuels as well Written for researchers graduate students and professionals in mechanical engineering chemical engineering energy and environmental engineering this book Covers global energy scenarios and future energy demands pertaining to clean energy technologies Provides systematic and detailed coverage of the processes and technologies used for biofuel production Includes new technologies and perspectives giving up to date and state of the art information on research and commercialization Discusses all conversion methods including biochemical and thermochemical Examines the environmental consequences of biomass based biofuel use **Senior Design Projects in Mechanical Engineering** Yongsheng Ma,Yiming Rong,2021-11-10 This book offers invaluable insights about the full spectrum of core design course contents systematically and in detail This book is for instructors and students who are involved in teaching and learning of capstone senior design projects in mechanical engineering It consists of 17 chapters over 300 illustrations with many real world student project examples The main project processes are grouped into three phases i e project scoping and specification conceptual design and detail design and each has dedicated two chapters of process description and report content prescription respectively The basic principles and engineering process flow are well applicable for professional development of mechanical design engineers CAD CAM CAE technologies are commonly used within many project examples Thematic chapters also cover student teamwork organization and evaluation project management design standards and regulations and rubrics of course activity grading Key criteria of successful course accreditation and graduation attributes are discussed in details In summary it is a handy textbook for the capstone design project course in mechanical engineering and an insightful teaching guidebook for engineering design instructors

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