

# C ONCURRENT ENGINEERING



CONTEMPORARY ISSUES AND  
MODERN DESIGN TOOLS

*Edited by*

HAMID R. PARSAEI AND  
WILLIAM G. SULLIVAN

CHAPMAN & HALL



*To our parents,  
Abolfazl Parsaei and Barat Atabaki,  
William H. Sullivan and Kathleen A. Glasstone*

## Concurrent Eng

Contemporary iss  
modern design

*Edited by*

**Hamid R. Par**

*Associate Professor  
Center for Computer-aided E  
University of Louisi  
USA*

and

**William G. Sul**

*Professor  
Department of Industrial and Syste  
Virginia Polytechnic Institute and  
USA*



**CHAPMAN & HA**

London · Glasgow · New York · Tokyo



TS176  
.C653  
1993

Published by Chapman & Hall, 2-6 Boundary Row, London SE1 8HN

Chapman & Hall, 2-6 Boundary Row, London SE1 8HN, UK

Blackie Academic & Professional, Wester Cleddens Road, Bishopbriggs, Glasgow G64 2NZ, UK

Chapman & Hall Inc., 29 West 35th Street, New York NY10001, USA

Chapman & Hall Japan, Thomson Publishing Japan, Hirakawacho Nemoto Building, 6F, 1-7-11 Hirakawa-cho, Chiyoda-ku, Tokyo 102, Japan

Chapman & Hall Australia, Thomas Nelson Australia, 102 Dodds Street, South Melbourne, Victoria 3205, Australia

Chapman & Hall India, R. S. Narayana, 22 Second Main Road, CIT East, Madras 600035, India

First edition 1993

© 1993 Chapman & Hall

Typeset in 10/12 Times by Interprint Limited, Malta  
Printed in Great Britain by the University Press, Cambridge

ISBN 0 412 46510 8

Apart from any fair dealing for the purposes of research or private study, or criticism or review, as permitted under the UK Copyright Designs and Patents Act, 1988, this publication may not be reproduced, stored, or transmitted, in any form or by any means, without the prior permission in writing of the publishers, or in the case of reprographic reproduction only in accordance with the terms of the licences issued by the Copyright Licensing Agency in the UK, or in accordance with the terms of licences issued by the appropriate Reproduction Rights Organization outside the UK. Enquiries concerning reproduction outside the terms stated here should be sent to the publishers at the London address printed on this page.

The publisher makes no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility or liability for any errors or omissions that may be made.

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication data available

LIBRARY OF CONGRESS  
5  
JUL 21 1993  
COPY  
CIP

LCCC#93-14639

## Contents

List of contributors	ix
Preface	xii
<b>Part One</b>	
<b>ORGANIZATION ISSUES IN CONCURRENT ENGINEERING</b>	<b>1</b>
1. Principles of concurrent engineering <i>Hyeon H. Jo, Hamid R. Parsaei and William G. Sullivan</i>	3
2. Concurrent engineering's roots in the World War II era <i>M. Carl Ziemke and Mary S. Spann</i>	24
3. Implementation: common failure modes and success factors <i>Stephen Evans</i>	42
4. Overcoming barriers to the implementation of concurrent engineering <i>Gary A. Maddux and William E. Souder</i>	61
5. Improving interpersonal communications on multifunctional teams <i>Michael E. Fotta and Ray A. Daley</i>	75
6. Scheduling of concurrent manufacturing projects <i>Adedeji B. Badiru</i>	93
<b>Part Two</b>	
<b>TOOLS AND TECHNIQUES OF CONCURRENT ENGINEERING</b>	<b>111</b>
7. Models of design processes <i>Ali Bahrami and Cihan H. Dagli</i>	113
8. A decision-based approach to concurrent design <i>Farrokh Mistree, Warren Smith and Bert Bras</i>	127
9. Concurrent optimization of product design and manufacture <i>Masataka Yoshimura</i>	159
10. Computer-based concurrent engineering systems <i>Michael J. O'Flynn and M. Munir Ahmad</i>	184

11. Multiattribute design optimization and concurrent engineering <i>Deborah L. Thurston and Angela Locascio</i>	207
12. Concurrent cell design and cell control system configuration <i>F. Frank Chen</i>	231
13. A generalized methodology for evaluating manufacturability <i>Srinivasa R. Shankar and David G. Jansson</i>	248
14. Evaluating product machinability for concurrent engineering <i>Dana S. Nau, Guangming Zhang, Satyandra K. Gupta and Raghu R. Karinhi</i>	264
15. Concurrent optimization of design and manufacturing tolerances <i>Chun Zhang and Hsu-Pin (Ben) Wang</i>	280
16. Design for human factors <i>Fariborz Tayyari</i>	297
<b>Part Three</b> <b>COST CONSIDERATIONS IN CONCURRENT ENGINEERING</b>	<b>327</b>
17. Designing to cost <i>Mahendra S. Hundal</i>	329
18. Economic design in concurrent engineering <i>James S. Noble</i>	352
<b>Part Four</b> <b>ARTIFICIAL INTELLIGENCE IN CONCURRENT ENGINEERING</b>	<b>373</b>
19. Application of expert systems to engineering design <i>Gary P. Moynihan</i>	375
20. A knowledge-based approach to design for manufacture using features <i>Eoin Molloy and J. Browne</i>	386
21. Concurrent accumulation of knowledge: a view of concurrent engineering <i>Robert E. Douglas, Jr. and David C. Brown</i>	402
22. Integrated knowledge systems for adaptive, concurrent design <i>Steven H. Kim</i>	413

23. Automating design for manufacturability systems approaches <i>A.R. Venkatachalam, Joseph M. Mellican, Miller</i>	
24. Modeling the design process with Petri nets <i>Andrew Kusiak and Hsu-Hao Yang</i>	
25. Neuro-computing and concurrent engineering <i>Cihan H. Dagli, Pipatpong Poshyanonda,</i>	

## Index



- Kuhn, T.S. (1970) *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago.
- Lansdown, J. (1987) *Design Studies*, 8(2), 76-81.
- Luckman, J. (1967) *Operational Research Quarterly*, 18(4), 345-58.
- Serbanati, L.D. (1987) *IEEE 9th International Conference of Software Engineers*, 190-7.
- Simon, H.A. (1969) *The Science of the Artificial*, MIT Press, Cambridge, MA.
- Suh, N.P., Bell, A.C. and Gossard, D.C. (1978) *Journal of Engineering for Industry, Transactions of ASME*, 100(2), 127-30.
- Suh, N.P. (1984) *Robotics and Computer Integrated Manufacturing*, 1(3/4), 398-401.
- Suh, N.P. (1990) *The Principles of Design*, Oxford University Press, New York, Oxford.
- Tyng, A. (1984) *Beginnings*, John Wiley & Son, New York.
- Yoshikawa, H. and Warman, E.A. (eds) (1987) *Proceedings of the IFIP WG.3.1 Working Conference 1985 (Tokyo)*, North-Holland, Amsterdam.

## A decision-based approach to concurrent design

Farrokh Mistree, Warren Smith and Bert E

Modern, computer-based concurrent design requires a holistic approach that integrates the representation, management and processing of information. Integration is possible through the 'standardization' of information management within a design process. We approach standardization from the perspective of decision-based design (DBD), namely, that 'the primary task of an engineer, in the design of an artifact, is to take decision-based actions. If decisions are foundational, we enable concurrent design processes through simultaneous analysis, synthesis and resolution of multiple design alternatives.'

In this chapter, we introduce the fundamental paradigms of decision-based design. We describe a decision-based design methodology called the decision support problem technique (DSPT). Specifically, we start by providing the theoretical ground and by stating the axioms needed to characterize decision support problems (DSPs). Introduced next is the formal syntax and semantics of DSPs. This generic protocol ensures the application of DSPT across varying domains of application by providing structured mappings between the designers' view of the problem and the particular syntax needed to facilitate solution. Finally, we provide examples from marine design to explicate our approach.

### 8.1 SHIP DESIGN CASE STUDIES - NOMENCLATURE

Variables:

L	or LBP	length between perpendiculars in meters	
B	or BEAM	ship design beam in meters	
T	or DRAFT	ship design draft in meters	
D	or DEPTH	ship design depth in meters	
$C_b$	or CB	block coefficient (ship's hull)	$= \frac{\text{Displaced volume}}{L \times B \times D}$

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.