

# An Integrated Approach for the Operational Design of a Cellular Manufacturing System

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## ABSTRACT

Shorter product life cycles, unpredictable demand patterns and the ever-shrinking time to market, have been constantly keeping the manufacturing firms under a lot of pressure. To face these challenges the manufacturing organizations have been shifting to Cellular Manufacturing (CM) due to its benefits of reducing manufacturing costs, increasing flexibility and delivering orders on time. Despite having several benefits, designing a Cellular Manufacturing System (CMS) for a real-life application is a tough ask. The main challenge is the part-machine grouping in cells. It becomes even more challenging when the group scheduling (GS) problem is handled alongside the part-machine clustering. To take up this challenge, an integrated model is developed during this research which handles the machine-part grouping and the GS problems, simultaneously. To optimize the multiple objectives of maximizing Grouping Efficacy (GE) and minimizing Makespan ( $C_{max}$ ), concurrently, a Hybrid Genetic Algorithm (HGA) based approach is developed. The proposed technique is validated through the famous benchmark problems, unlike the several approaches already available in literature. The computational results have shown that the integrated approach, presented in this paper, is more effective as compared to a sequential technique. Also, its accuracy remains intact even if it is applied to large sized problems.

**Keywords:** Cellular Manufacturing System, Grouping Efficacy, Makespan, Hybrid Genetic Algorithm

## 1. INTRODUCTION

Cellular Manufacturing System (CMS) is a manufacturing concept based on the philosophy of Group Technology (GT). It is implemented by arranging the entire manufacturing system into cells, where parts having similar processing requirements are processed inside a single cell. This particular arrangement (identification of part families and corresponding machine groups) of the system makes the production flow simpler and shorter which significantly decreases the lead times and material handling costs. This is the reason that

CMS is largely considered to have the ability of economically producing parts in medium volume and variety as compared to the conventional manufacturing systems. Main cause for the success of CMS is its capacity to reduce: set-up times, work in process, lot sizes, production equipment and enhanced productivity [1]. Cellular Manufacturing (CM) is the approach which is best suited to the present day's competitive market environment where manufacturers consistently strive to increase their efficiency by reducing delivery times and improving product quality without substantially enhancing investments [2]. Despite being hugely beneficial,

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# Cellular Manufacturing Systems An Integrated Approach

**Fethi Calisir, Orhan Korhan**



## **Cellular Manufacturing Systems An Integrated Approach:**

**CELLULAR MANUFACTURING SYSTEMS** B.S. NAGENDRA PARASHAR, 2008-10-24 Cellular manufacturing an application of group technology is a stepping stone to achieve world class manufacturing status It has emerged as an important technique to cope up with fast changing industrial demands for the application of newer manufacturing systems This comprehensive and well written text deals with all facets of cellular manufacturing right from introduction to application in a chronological order The book first introduces cell formation techniques followed by elimination of exceptional components evaluation of solutions cell characteristics and production control issues like scheduling line balancing and inventory control Finally it discusses about the application of cellular manufacturing in a large public sector The text is supported by numerous figures tables and examples and also furnishes simple algorithms for complex methods Primarily intended for the postgraduate students of mechanical engineering and production engineering with specialization in manufacturing systems group technology it will also be useful for the researchers scientists and professionals as a reference book

**An Integrated Approach in the Design of Cellular Manufacturing Systems for Dynamic Production Requirements** Fantahun Melaku Defersha, 2006 **An Integrated Approach for the Design and Operation of Cellular Manufacturing Systems** Wen-Shiom Lian, 1989 Agile Manufacturing A. Gunasekaran, 2001-01-25 Agile manufacturing is

defined as the capability of surviving and prospering in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets driven by customer designed products and services Critical to successfully accomplishing AM are a few enabling technologies such as the standard for the exchange of products STEP concurrent engineering virtual manufacturing component based hierarchical shop floor control system information and communication infrastructure etc The scope of the book is to present the undergraduate and graduate students senior managers and researchers in manufacturing systems design and management industrial engineering and information technology with the conceptual and theoretical basis for the design and implementation of AMS Also the book focuses on broad policy directives and plans of agile manufacturing that guide the monitoring and evaluating the manufacturing strategies and their performance A problem solving approach is taken throughout the book emphasizing the context of agile manufacturing and the complexities to be addressed Operations Management Research and Cellular Manufacturing

Systems: Innovative Methods and Approaches Modrák, Vladimír, Pandian, R. Sudhakara, 2011-10-31 This book presents advancements in the field of operations management focusing specifically on topics related to layout design for manufacturing environments Provided by publisher *Handbook of Cellular Manufacturing Systems* Shahrukh A.

Irani, 1999-04-15 Cellular manufacturing CM is the grouping of similar products for manufacture in discrete multi machine cells It has been proven to yield faster production cycles lower in process inventory levels and enhanced product quality Pioneered on a large scale by Russian British and German manufacturers interest in CM methods has grown steadily over the

past decade However there continues to be a dearth of practical guides for industrial engineers and production managers interested in implementing CM techniques in their plants Bringing together contributions by an international team of CM experts the Handbook of Cellular Manufacturing Systems bridges this gap in the engineering literature **Manufacturing System** Faieza Abdul Aziz,2012-05-16 This book attempts to bring together selected recent advances tools application and new ideas in manufacturing systems Manufacturing system comprise of equipment products people information control and support functions for the competitive development to satisfy market needs It provides a comprehensive collection of papers on the latest fundamental and applied industrial research The book will be of great interest to those involved in manufacturing engineering systems and management and those involved in manufacturing research *Cellular Manufacturing Systems* N. Singh,D. Rajamani,2012-12-06 Batch manufacturing is a dominant manufacturing activity in the world generating a great deal of industrial output In the coming years we are going to witness an era of mass customization of products The major problems in batch manufacturing are a high level of product variety and small manufacturing lot sizes The product variations present design engineers with the problem of designing many different parts The decisions made in the design stage significantly affect manufacturing cost quality and delivery lead times The impacts of these product variations in manufacturing are high investment in equipment high tooling costs complex scheduling and loading lengthy setup time and costs excessive scrap and high quality control costs However to compete in a global market it is essential to improve the productivity in small batch manufacturing industries For this purpose some innovative methods are needed to reduce product cost lead time and enhance product quality to help increase market share and profitability What is also needed is a higher level of integration of the design and manufacturing activities in a company Group technology provides such a link between design and manufacturing The adoption of group technology concepts which allow for small batch production to gain economic advantages similar to mass production while retaining the flexibility of job shop methods will help address some of the problems *Planning, Design, and Analysis of Cellular Manufacturing Systems* A.K. Kamrani,H.R. Parsaei,D.H. Liles,1995-04-11 Leading researchers in the field of cellular manufacturing systems from academia and industry have contributed to this volume The book aims to report the latest developments and address the central issues in the design and implementation of cellular manufacturing systems Cellular Manufacturing CM is one of the major concepts used in the design of flexible manufacturing systems CM also known as group production or family programming can be described as a manufacturing technique that produces families of parts within a single line or cell of machines The first part of the book describes various techniques for design and modeling of cellular manufacturing systems The second part is concerned with performance measure and analysis followed by a section which presents the applications of artificial intelligence and computer tools in cellular manufacturing systems **Computer Integrated Manufacturing (Iccim '91): Manufacturing Enterprises Of The 21st Century - Proceedings Of The International Conference** B S Lim,1991-10-02 In the 21st

century computer integrated manufacturing CIM systems will not only be the economic development tools but will also be the essential means of achieving a higher level of flexibility cohesiveness and performance CIM systems are beginning to settle into our society and industries with greater emphasis on the integration of economic cultural and social aspects together with design planning factory automation and artificial intelligent systems This volume of proceedings brings together 10 keynote and invited speaker addresses and over 180 papers by practitioners from 28 countries It documents current research and in depth studies on the fundamental aspects of advanced CIM systems and their practical applications The papers fall into 3 main sections CIM Related Issues Industrial AI Applications Aspects and Concurrent Engineering Advanced Design Simulation and Flexible Manufacturing Systems Design and Management of Manufacturing Systems Arkadiusz Gola,2021-09-02 Although the design and management of manufacturing systems have been explored in the literature for many years now they still remain topical problems in the current scientific research The changing market trends globalization the constant pressure to reduce production costs and technical and technological progress make it necessary to search for new manufacturing methods and ways of organizing them and to modify manufacturing system design paradigms This book presents current research in different areas connected with the design and management of manufacturing systems and covers such subject areas as methods supporting the design of manufacturing systems methods of improving maintenance processes in companies the design and improvement of manufacturing processes the control of production processes in modern manufacturing systems production methods and techniques used in modern manufacturing systems and environmental aspects of production and their impact on the design and management of manufacturing systems The wide range of research findings reported in this book confirms that the design of manufacturing systems is a complex problem and that the achievement of goals set for modern manufacturing systems requires interdisciplinary knowledge and the simultaneous design of the product process and system as well as the knowledge of modern manufacturing and organizational methods and techniques **Artificial Intelligence in Mechanical and Industrial Engineering** Kaushik Kumar,Divya Zindani,J. Paulo Davim,2021-06-20 Artificial Intelligence in Mechanical and Industrial Engineering offers a unified platform for the dissemination of basic and applied knowledge on the integration of artificial intelligence within the realm of mechanical and industrial engineering The book covers the tools and information needed to build successful careers and a source of knowledge for those working with AI within these domains The book offers a systematic approach to explicate fundamentals as well as recent advances It incorporates various case studies for major topics as well as numerous examples It will also include real time intelligent automation and associated supporting methodologies and techniques and cover decision support systems as well as applications of Chaos Theory and Fractals The book will give scientists researchers instructors students and practitioners the tools and information needed to build successful careers and to be an impetus to advancements in next generation mechanical and industrial engineering domains Handbook of Research on Applied

Optimization Methodologies in Manufacturing Systems Faruk Yılmaz, Ömer, Tüfekçi, Süleyman, 2017-11-30 Today's manufacturing systems are undergoing significant changes in the aspects of planning production execution and delivery. It is imperative to stay up to date on the latest trends in optimization to efficiently create products for the market. The Handbook of Research on Applied Optimization Methodologies in Manufacturing Systems is a pivotal reference source including the latest scholarly research on heuristic models for solving manufacturing and supply chain related problems. Featuring exhaustive coverage on a broad range of topics such as assembly ratio, car sequencing and color constraints, this publication is ideally designed for practitioners seeking new comprehensive models for problem solving in manufacturing and supply chain management.

**Trends in Computer Science** Susan Shannon, 2004 The books in this series present leading edge research in the field of computer research technology and applications. Each contribution has been carefully selected for inclusion based on the significance of the research to the field. Summaries of all chapters are gathered at the beginning of the book and an in depth index is presented to facilitate access.

*Collaborative Engineering* Ali K. Kamrani, Emad Abouel Nasr, 2008-07-08 Collaborative Engineering (CE) is the systematic approach to the integrated concurrent design of products and related processes including manufacturing, product service and support. This approach is intended to cause the developers to consider all elements of the product life cycle from conception through disposal including quality, cost, schedule and user requirements. The objective of Collaborative Engineering is to reduce the system product development cycle time through a better integration of resources, activities and processes. Collaborative Engineering Theory and Practice offers insights into the methods and techniques that enable implementing a Collaborative Engineering concept on product design by integrating capabilities for intelligent information support and group decision making utilizing a common enterprise network model and knowledge interface through shared ontologies. The book is also a collection of the latest applied methods and technology from selected experts in this area which will be structured in a way useful in assisting and structuring the course.

**Operations and Production Systems with Multiple Objectives** Behnam Malakooti, 2014-02-03 The first comprehensive book to uniquely combine the three fields of systems engineering, operations production systems and multiple criteria decision making optimization. Systems engineering is the art and science of designing engineering and building complex systems combining art, science, management and engineering disciplines. Operations and Production Systems with Multiple Objectives covers all classical topics of operations and production systems as well as new topics not seen in any similar textbooks before: small scale design of cellular systems, large scale design of complex systems, clustering, productivity and efficiency measurements and energy systems. Filled with completely new perspectives, paradigms and robust methods of solving classic and modern problems, the book includes numerous examples and sample spreadsheets for solving each problem, a solutions manual and a book companion site complete with worked examples and supplemental articles. Operations and Production Systems with Multiple Objectives will teach readers how operations and production systems are designed.

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engineering operations production and manufacturing      **Advanced Computing and Communication Technologies**

Jyotsna Kumar Mandal,Dhananjay Bhattacharyya,Nitin Auluck,2018-07-05 The book includes papers on a wide range of emerging research topics spanning theory systems and applications of computing and communication technologies viz Nonlinear Dynamics in Cryptography Discrete domain Swarm Robotics Machine Learning Facility Layout Problem Crowdfunding Projects Deep Learning MHD Nanofluid Flow Medical Diagnostics Human Computer Interface Social Networking System Performance Wireless Sensor Networks Cognitive Radio Networks Antenna Design etc presented at the 11th International Conference on Advanced Computing and Communications Technologies 11th ICACCT 2018 held on 17 18 February 2018 at Asia Pacific Institute of Information Technology Panipat India      Supply Chain Management Under Fuzziness

Cengiz Kahraman,Başar Öztayşi,2014-02-15 Supply Chain Management Under Fuzziness presents recently developed fuzzy models and techniques for supply chain management These include fuzzy PROMETHEE fuzzy AHP fuzzy ANP fuzzy VIKOR fuzzy DEMATEL fuzzy clustering fuzzy linear programming and fuzzy inference systems The book covers both practical applications and new developments concerning these methods This book offers an excellent resource for researchers and practitioners in supply chain management and logistics and will provide them with new suggestions and directions for future research Moreover it will support graduate students in their university courses such as specialized courses on supply chains and logistics as well as related courses in the fields of industrial engineering engineering management and business administration      **Grouping Genetic Algorithms**

Michael Mutingi,Charles Mbohwa,2016-10-04 This book presents advances and innovations in grouping genetic algorithms enriched with new and unique heuristic optimization techniques These algorithms are specially designed for solving industrial grouping problems where system entities are to be partitioned or clustered into efficient groups according to a set of guiding decision criteria Examples of such problems are vehicle routing problems team formation problems timetabling problems assembly line balancing group maintenance planning modular design and task assignment A wide range of industrial grouping problems drawn from diverse fields such as logistics supply chain management project management manufacturing systems engineering design and healthcare are presented Typical complex industrial grouping problems with multiple decision criteria and constraints are clearly described using illustrative diagrams and formulations The problems are mapped into a common group structure that can conveniently be used as an input scheme to specific variants of grouping genetic algorithms Unique heuristic grouping techniques are developed to handle grouping problems efficiently and effectively Illustrative examples and computational

results are presented in tables and graphs to demonstrate the efficiency and effectiveness of the algorithms Researchers decision analysts software developers and graduate students from various disciplines will find this in depth reader friendly exposition of advances and applications of grouping genetic algorithms an interesting informative and valuable resource

*Industrial Engineering in the Digital Disruption Era* Fethi Calisir,Orhan Korhan,2020-03-16 This book gathers extended versions of the best papers presented at the Global Joint Conference on Industrial Engineering and Its Application Areas GJCIE held on September 2 3 2019 in Gazimagusa North Cyprus Turkey It covers a wide range of topics including decision analysis supply chain management systems modelling and quality control Further special emphasis is placed on the state of the art and the challenges of digital disruption as well as effective strategies that can be used to change organizational structures and eliminate the barriers that are keeping industries from taking full advantage of today s digital technologies



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