Preface

Large or complex design problems often require specialized knowledge from many different fields. Several designers, each with specific core competencies, interact in the design process. During the conceptual phase of the design life cycle, emphasis is mainly focused on establishing the requirements and their proper interaction. The need for integration continues when the design enters the preliminary and detail design phases. Figure P.1 illustrates the scope of the design process for any complex system.

In the virtual, integrated, concurrent design environment, designers interact by sharing information and reaching agreements. By considering proper integration and interaction from the beginning, the problems with the final integration of activities will be significantly reduced.

The surge of the information technology, especially the Internet, provides the infrastructure necessary for an integrated and distributed engineering environment. In this environment, teams of engineers from different parts of organizations could collaborate together toward design, development, and integration. The virtual product design and integration environment would require the collaboration from different teams and functions involved throughout the product life cycle. This environment would require tools that are used for sharing information and knowledge in order to reach an understanding which would contribute to a design which satisfies the customer needs. This environment also provides the means necessary to share tools that are colocated and geographically dispersed.

The distributed environment is highly heterogeneous, where designers, engineers, resources, and models are distributed and not centralized in one location, and groups within the company work together across the computer network. In this environment, many interrelated design decisions are being made in order to meet the objectives. Functions within companies may include design, manufacturing, cost, and life cycle considerations. A collaborative and integrated environment would provide the necessary insight and tools to the designers to quickly construct and reconstruct models of complex products and to evaluate, optimize, and select the better alternative designs. This distributed design environment facilitates the collaborative development of models and exchange of design information and knowledge.

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 developers to consider

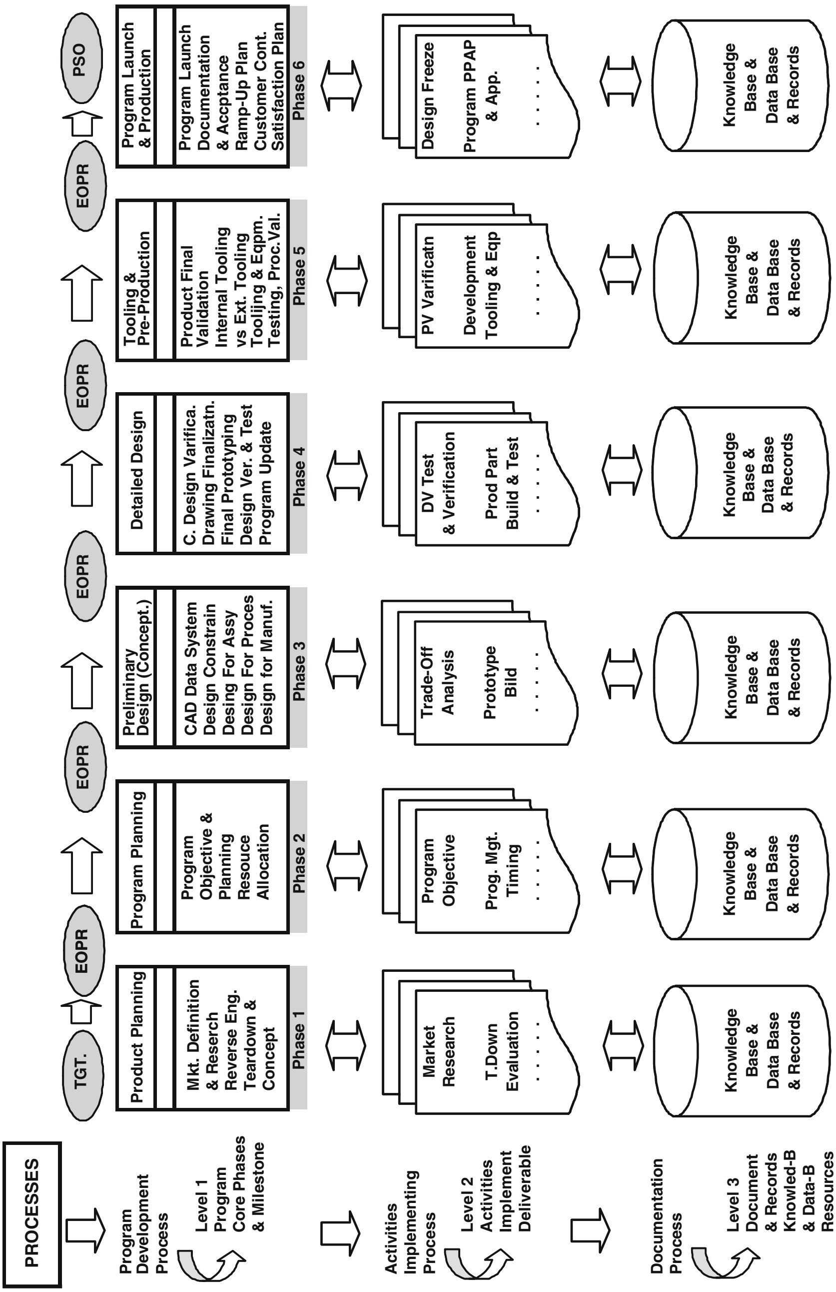

Fig. P.1 Systems engineering design paradigm all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements. The objective of CE is to reduce the development cycle time through a better integration of resources, activities, and processes. This book offers insights into the methods and techniques that enable implementing a CE concept on product design by integrating capabilities for intelligent information support and group decision-making utilizing a common enterprise network model and knowledge interface. The book is a collection of the latest applied methods and technology from selected experts in this area. It is developed to serve as a resource for both researcher and practitioners. It offers the following:

1. Latest research results in CE.
2. Collection of materials from experts in selected topics.
3. Applied methods developed in the field of CE.
4. CE with the emphasis on product design.
5. Discussion on the need and solutions for new engineering paradigm and philosophy required for CE, including the IT infrastructure.
6. Principles and applications of the collaborative environment.

In Chap. 1, Kamrani discusses the requirement for an open and collaborative manufacturing environment. Technologies to support product life cycles and suitable methodologies, tools, and techniques will be the focus of this chapter. In Chap. 2, Kamrani and Vijian provide a discussion on template-based integrated product development life cycle. General guideline for design of a template-based system for integrated design is outlined and a case study for design of electrical motor is provided. In Chap. 3, Feng describes the concept of Six Sigma as a methodology to manage process variations that cause defects, defined as unacceptable deviation from the mean or target; and to systematically work toward managing variation to eliminate those defects. Also, statistical methods for quality improvement, such as statistical models, control charts, process capability, process experimentation, model building, and the evaluation of measurement processes, are discussed. Supply chain workflow modeling using ontologies is presented by Chandra in Chap. 4. One of the primary objectives of supply chain information support system is to develop conceptual design of organizational and process knowledge models which facilitate optimal supply chain management. Data mining (DM) as a process of automatically searching large volumes of data for patterns recognitions is presented by Kamrani and Gonzalez in Chap. 5. DM is a fairly recent and contemporary topic in computer science. However, DM applies many computational techniques which are explained in this chapter. A step-by-step methodology for DM is presented in this chapter. Chapter 6 by Nasr and Kamrani provides an overview of intelligent design and manufacturing (CAD/CAM), the most important reasons of using CAD systems in the manufacturing environment, computer-integrated manufacturing (CIM), the implementation of automation in the production organization, the role of CAD/CAM systems in the manufacturing facility, the CAM cycle in a feature-based design environment, and different types of features. Moreover, this chapter provides a methodology for feature analysis and extraction of prismatic parts for CAM applications is developed and presented. This approach aims to achieve the integration between CAD and CAM. Simulation and optimization are clearly two of the most widely implemented operation research and management science techniques in practice, although several obstacles have limited the acceptance and application of integrated simulation and optimization techniques. In Chap. 7, Asiabanpour, Mokhtar, and Houshman provide a discussion of rapid manufacturing as a technique for manufacturing solid objects by the sequential delivery of energy and/or material to specified points in space to produce that solid. Current practice is to control the manufacturing process by computer using a mathematical model created with the aid of a computer. Also, this chapter discusses the large advantage of rapid manufacturing in speed and cost overhead compared to alternative polymer or metal manufacturing techniques such as powder metallurgy manufacturing or die casting. Moreover, in this chapter, rapid manufacturing as an application of solid freeform fabrication for direct manufacturing of goods is addressed. Unlike methods such as computer numerical control (CNC) milling, these techniques allow the fabricated parts to be of high geometric complexity. In Chap. 8, Assavapokee and Mourtada introduce the basic concept of simulation-based optimization and illustrate its usefulness and applicability for generating the manpower planning of airline's cargo service call center. Because of the continuous increase in oil prices, and combined with many other factors, the airline industry is currently facing new challenges to keep its customers satisfied. In this work, reinforcement learning (RL) and Markov decision process (MDP) are utilized to build and solve the mathematical model to determine the appropriate staffing policy at the airline's cargo service call center.

A robot is a mechanical device that sometimes resembles a human and is capable of performing a variety of often complex human tasks on command or by being programmed in advance. Robotics of the years has seen an immense growth both technologically and otherwise. The recent advances in the manufacturing processes have necessitated the need to enable robots to be more autonomous. Autonomy simply means the ability of the robot to be independent, that is, intelligent. It should be understood that the mimicking of human intelligence and neural function is a relatively nascent research area and has significant strides to overcome in order to achieve this. Chapter 9 by Ibekwe and Kamrani discusses topics related to the design of an autonomous robot. Comprehensive discussion of the modular design, including types of modularity, the characteristics of modular systems, and the development of modular and reconfigurable manufacturing systems, is provided in Chap. 10. In this chapter, Salhieh and Kamrani present a new network-based solution methodology for solving the problem of modularity and classification. Complexity within the manufacturing system comes from the variability and uncertainty in the manufacturing system and from the dynamic nature of the manufacturing environment which increases the number of decisions that need to be made with the difficulty to predict the future response (outcomes) of these decisions. The uncertainty reason can be represented by market demand, product life cycle on the macro scale to tool wear, machine/component breakdown on the micro scale. Variability covers the stochastic nature of manufacturing such as operator performance, work material properties, process repeatability, and supply reliability. The basic elements of the complexity are the absolute quantity of information, the diversity of the information, and the information content. The ability of a production line to produce a product mix requires shop floor monitoring, and information flow giving the required position of the product and the parts for each stage in the production line. A topic related to complexity within the manufacturing system is presented in Chap. 11 by Kamrani and Adat. A simulation-based methodology is presented in order to mitigate the risks associated with manufacturing complexity. Agile manufacturing systems (AMS) will be considered as the next industrial revolution. They are manufacturing and/or management philosophies that integrate the available technology, people, manufacturing strategies, and management systems. Although agility is the set of capabilities and competences that the manufacturing firms need to thrive and prosper in a continuously changing and unpredictable business environment, measuring the level of agility in these firms is still unexplored according to the capabilities and competences. In Chap. 12, Garbie, Parsaei, and Leep present a new solution methodology for manufacturing cell design and analysis.

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