A New framework for Agile manufacturing

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Abstract

Agile manufacturing (AM) is a new concept in manufacturing intended to improve the competitiveness of "rms. Manufacturing processes based on AM are characterized by customer}supplier integrated process for product design, manufacturing, marketing, and support services. This needs decision-making at functional knowledge levels, stable unit costs, #exible manufacturing, easy access to integrated data, and modular production facilities. Agile manufacturing requires enriching of the customer, co-operating with competitors, organizing to manage change, uncertainty and complexity, and leveraging people and information. In the recent years, a number of research papers have been published in the area of AM. However, a framework for the development of AM has not received due attention from both researchers and practitioners. Realizing the importance of agile manufacturing in the 21st century manufacturing competitiveness, an attempt has been made in this paper to review the literature available on AM with the objective to: (i) identify key strategies and techniques of AM, (ii) suggest some future research directions and (iii) develop a framework for the development of agile manufacturing systems (AMSs) along four key dimensions which include strategies, technologies, systems and people. (1999 Elsevier Science B.V. All rights reserved

Introduction

Businesses are restructuring and re-engineering themselves in response to the challenges and demands of 21st century. The 21st century businesses will have to overcome the challenges of demanding customers seeking high quality, low cost products, responsive to their speci"c and rapidly changing needs [1]. Agility addresses new ways of running companies to meet these challenges. Agility is about casting o! those old ways of doing things that are no longer appropriate } changing pattern of traditional operation. In a changing competitive environment, there is a need to develop organizations and facilities signi"cantly more #exible and responsive than current existing ones [2,3]. Agile manufacturing can be de"ned as the capability of surviving and prospering in a competitive environment of continuous and unpredictable change by reacting quickly and e!ectively to changing markets, driven by customer-designed products and services [4]. Agile manufacturing is notabout small-scale continuous improvements, but an entirely di!erent way of doing business [5]. Agile manufacturing is a new expression that is used to represent the ability of a producer of goods and services to thrive in the face of continuous change. These changes can occur in markets, in technologies, in business relationships and in all facets of the business enterprise [6]. Agile manufacturing requires to meet the changing market requirements by suitable alliances based on core-competencies, organizing to manage change and uncertainty, and leveraging people and information

Agile manufacturing is a vision of manufacturing that is a natural development from the original concept of &lean manufacturing'. In lean manufacturing, the emphasis is on cost-cutting. The requirement for organizations and facilities to become more #exible and responsive to customers led to the concept of the &agile' manufacturing as a di!erentiation from the

&lean' organization. This requirement for manufacturing to be able to respond to unique demands moves the balance back to the situation prior to the introduction of lean production, where manufacturing had to respond to whatever pressures were imposed on it, with the risks to cost and quality. The move to lean production from agile

The organization of the paper is as follows: Section 2 presents the classi"cation of the literature available and a brief review of the previous research on AM. Comments on the literature and future research directions are discussed in Section 3. A framework for the design of AM is presented in Section 4. Section 5 concludes the paper.

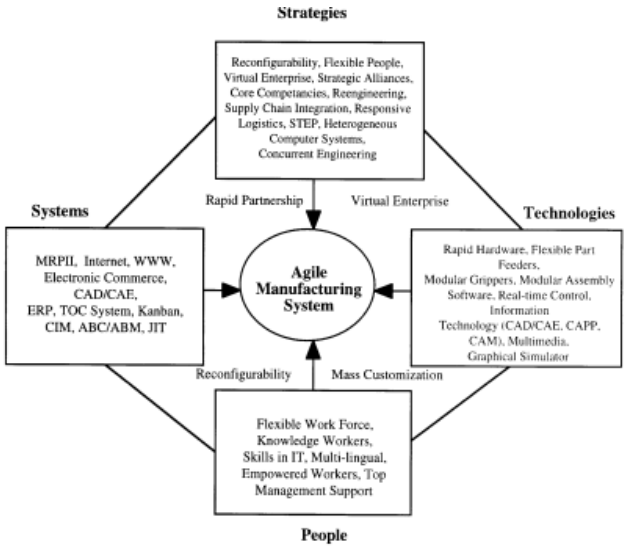

Fig. 1. Development of an agile manufacturing system.

Classi5cation and a review of previous research on agile manufacturing

In this section, a classi"cation of the literature available on AM and a brief review of each article are presented. Agile manufacturing includes rapid product realization, highly #exible manufacturing, and distributed enterprise integration. Technology alone does not make an agile enterprise. Every company must "nd the right combination of culture, business practices, and technology that are necessary to make itself agile. In this paper, the focus is on the operating conditions of factories organized as #exible networks of processors based on core competencies. With this scope in mind, an attempt has been made in this section to review the literature on AM.

Classixcation of the literature on agile manufacturing

The literature available on AM has been classi- "ed based on the nature and the focus of agile enablers which include criteria such as strategies, technologies, systems and people. A classi"cation scheme based on the nature and application of the models is proposed for easy understanding of the research work on AM. The literature available under each criterion have been further grouped under sub-classi"cation to improve to the clarity of the presentation and highlight some key factors of AM under each classi"cation. The main objective of this particular classi"cation is to develop a suitable framework for AMSs along these four dimensions/criteria. Agility should be in all areas of manufacturing to e!ectively respond to changing market requirements. Achieving agility therefore requires #exibility and responsiveness in strategies, technologies, people and systems. Table 1 shows the classi"cation of the literature on AM and the corresponding references on the basis of strategies, technologies, systems and people. It is imperative to mention that the literature surveyed in this paper are not exhaustive, but only a representative.

Comments on agile manufacturing literature and future research directions

Theoretically derived hypotheses and empirical studies to test them are conspicuously absent fromstudies of the agile organization. A study by Hoyt et al. [62] a scene in this direction. Although it seems intuitive that the ability to respond to dynamic and unpredictable

changes in the environment should contribute to a company's success, this fact has not been scienti"cally tested. The survey of literature has provided further insights into the AM concepts and systems including strategies, technologies, systems and people. From the analysis of AM literature, the following are some of the future research directions that would assist in achieving agility in manufacturing more e!ectively [17].

(1) ers for agile enterprises based on core-competencies and market forces needs to be developed. Criteria for selecting partners of agile enterprise should be identi"ed with the help of suitable conceptual and empirical research.

(2) (ii) A framework for determining the type and level of di!erent skills required for agile enterprise should be developed using multiple site case studies. Furthermore, the nature of training and education required for workforce should be precisely de"ned taking into account the geographically dispersed partners in AM environments. Suitable information systems need to be developed for determining the type of skills and numbers of workers required in agile environments.

(3) The infrastructure and organizational characteristics of agile enterprise can be determined by developing a suitable theoretical framework and testing them with real life manufacturing environments. This framework essentially centers around the nature of information and material #ows in AM enterprise. The issues of temporary alliances based on core competencies are to be embedded in the proposed empirical studies.

(4) In agile enterprises, supply chain links are often temporary and hence #exible. Therefore, there is need to develop suitable performance measurements and investment justi"cation techniques for this environment.

(5) An investigation on the selection of suitable architectures for agile enterprises would o!er further insights into the design of AMSs. Also, appropriate capacity planning and scheduling methods are to be devised to support the e!ectiveoperations of physically distributed virtual enterprises in AM environments.

(6) In a physically distributed agile enterprise environment, there is a need for a di!erent quality management system. All the modern quality management strategies and methods can be used for agile environments, but need to be modi"ed taking into account the recon- "gurability and dynamics of agile organizations.

(7) The cost accounting systems such as ActivityBased Costing (ABC) would be suitable for advanced manufacturing environments. However, considering the characteristics of agile enterprise, the application of ABC needs further investigation. Physically distributed manufacturing environment demands a simple cost accounting system to overcome the di$- culties of communication, integration and domestic regulations among geographically dispersed partners.

(8) Gaining rapid response to changing customer demand requires equally agile logistics. Logistics can be helped by appropriate product design and tooling to ease materials handling. Fewer stock lines and greater interchangeability of items reduce the working capital and the risk of obsolescence of slow moving lines. The issue of logistics in AM environments has not received signi"cant attention from researchers. For example, what sort of systems would be suitable for purchasing and distribution of goods would be appropriate in AM environments which include VE based on temporary alliances need to be investigated further. Realizing the importance of a framework for developing AMSs, an attempt has been made in this paper to develop a framework for AM based on

the literature survey and other reported case experiences.

In agile enterprise where manufacturing partners share product related data to come up with new, customized, and high quality products at minimal leadtimes. The principles of group technology (GT) can be used. The information on product design is assumed to be available in the product databases of distributed partners, and can be generated through an existing GT design processor. A software system using object-oriented technology will be useful in implementing the procedure [48]. Agile manufacturing systems can bene"tsigni"cantly from a database support. An AM database system (AMDS) designed for capturing and manipulating the operational data of a manufacturing cell will be helpful

Summary and conclusions

With the rapid changes taking place in the global market, it becomes clear that enterprises working on an AM base or in mass customization will rapidly become leaders. In order to design e$cient production systems and factories operating in these manufacturing paradigms, new design approaches need to be developed. This paper synthesizes some of the research work done on the AM to develop a framework for the development of AMSs. The model presented in this paper can be tested with the help of suitable empirical and multiple case studies. Also, classical organization theory and strategy research methods are useful for the characterization of AM organizations. The subject of AM needs more feasibility studies from the perspectives of establishing VE, temporary alliances and their implications on the relationship with labor unions and jurisdictions. The following are some of the major issues that could be considered by researchers and practitioners when developing AMSs:

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