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Reconfigurability and Flexibility: The Important Aspects of Advanced Manufacturing System

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Abstract

Reconfigurable Manufacturing System (RMS) is a novel manufacturing systems paradigm that intents to achieve a cost-effective and rapid system change, as and when needed, by integrating principles of convertibility, diagnosability modularity, scalability, integrability, and flexibility. RMS promises customized flexibility on demand in a short time, while Flexible Manufacturing Systems (FMSs) provides generalized flexibility designed for the anticipated variations and built-in a priority. The present review shows the different aspects of flexibility and reconfigurability. It also highlights the challenges and issues of reconfigurable manufacturing systems.

Keywords: Flexibility, manufacturing systems, reconfiguration

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INTRODUCTION

A novel competitive environment for industrial products and services is emerging and changing the way in which manufacturing enterprises are designed and managed. Competitive advantages in the new global economy will belong to manufacturing enterprises that are capable of responding rapidly to the demand for customized, high-quality products. The notion of flexible manufacturing was introduced in response to the need for mass customization and for greater responsiveness to changes in products, production technology, and markets. [1]

Reconfigurable Manufacturing System (RMS) is designed at the inception for a possible rapid change in structure, as well as in hardware and software components, in order to quickly adjust production capacity and functionality within a part of family. On the other hand, Flexible Manufacturing Systems (FMS) is a system whose machines are able to perform operations on a random sequence of parts of different types with little or no time or other expenditure for changeover.

In practice, FMSs consist of processing stations and material handling systems that are entirely under computer control. In short, RMS is a manufacturing system with customized flexibility and FMS is a manufacturing system with general flexibility. [2] Flexible manufacturing systems were also developed to address mid-volume, mid-variety production needs. Similarities between parts in design and/or manufacture were used to achieve economy of scope.

Flexible manufacturing systems (FMSs) anticipated these variations and built-in flexibility a priori; hence they are more robust but have high initial capital investment cost.

The flexibility attributes are sometimes underused. In the nineties, optimality, agility, waste reduction, quality, and lean manufacturing were identified as key drivers and goals for ensuring survival in a globally competitive market.

The reconfigurable manufacturing concept has emerged in the last few years in an effort to achieve changeable functionality and scalable capacity. [3,4] It suggests a manufacturing system where machine components, machines, cells, or material handling units can be integrated or interchanged as needed to respond quickly to changing requirements.

Such a fully reconfigurable system does not exist yet but is the matter of major research efforts globally, with special emphasis on the hardware and machine control aspects.

MANUFACTURING SYSTEM RECONFIGURATION

The rapidly changing manufacturing environment characterized by aggressive competition globally and prompt changes in process technology requires attention to prolonging the life of manufacturing systems by making them easily up-gradable and into which new technologies and new functions it can be readily integrated.

RMS is a visionary challenge for manufacturing enterprises and is considered as the next manufacturing model. [5, 6] They would use modular equipment, as building blocks to comprehend the required system functionality for the production of a part family.

Instead of providing a general flexibility through the use of equipment with built-in high functionality as in FMSs, RMSs delivers customized flexibility through scalability and reconfiguration as needed when needed to meet market requirements.[7, 8]

For a manufacturing system to be readily reconfigurable, the system must have certain key characteristics[8] including:

i) Convertibility to allow quick changeover between products and quick system adaptability for future products,
ii) Scalability to incrementally change capacity rapidly and economically,
iii) Diagnosability to identify quickly the sources of quality and reliability problems,
iv) Customization to match designed system capability and flexibility to applications, and
v) Integrability for both ready integration and future introduction of new technology,
vi) Modularity of component design.

The Figure 1 shows the schematic representation of manufacturing system reconfiguration.

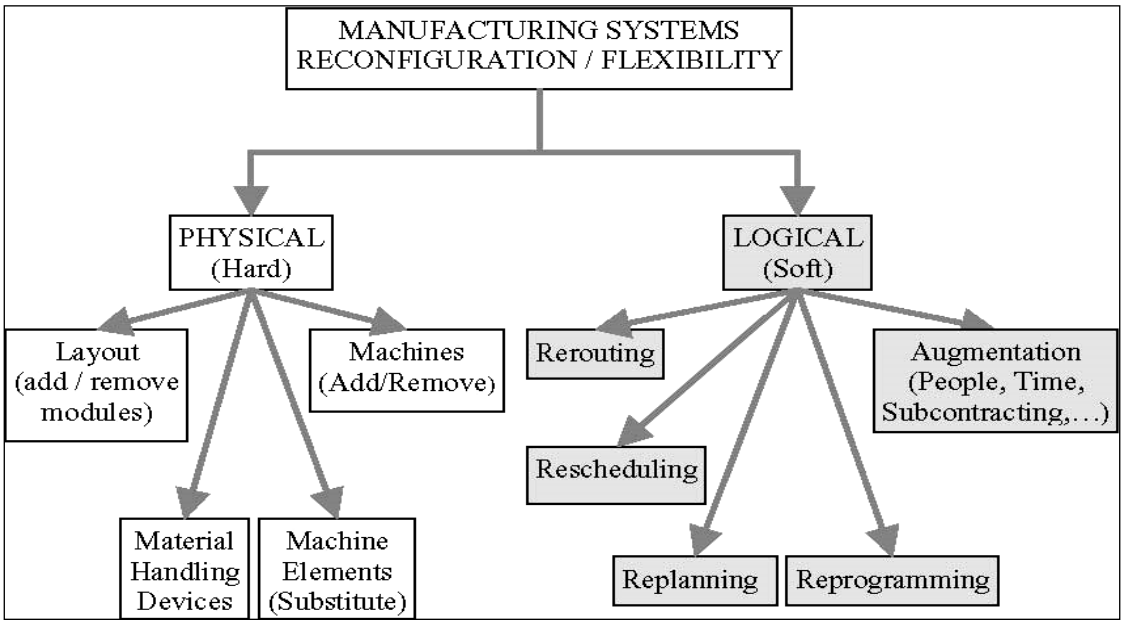

Fig. 1: *Manufacturing Systems Reconfiguration.* [5]

CHALLENGES AND ISSUES

The concept of reconfigurable manufacturing system has sparked interest in the academic and industrial communities. It has encouraged active research into supportive areas that are proving very beneficial to existing manufacturing systems. This technique have several challenges and issues [9, 10] as follows:

1. The hardware and software enabling technologies.
2. Reconfigurable logical support systems such as logistics, production planning and control, process planning, tooling, and fixtures.
3. Balance of hard and soft capacity and functionality scalability options.
4. Design of machines, systems, and controls for flexibility, changeability, and reconfiguration and integration with current systems and software.
5. Models to determine adequate levels of changeability, flexibility, and reconfigurability required for different applications.
6. Issues of manufacturing machine concepts: design, manufacturing and integration of reconfigurable and intelligent machines.
7. Issue of theories and methodologies: application of concurrent engineering and life cycle engineering theories.
8. Issue of supporting technologies: design and development of web-based information systems for integrated machine development.
9. References.

CONCLUSION

The new generation of advanced manufacturing systems is forcing a shift from mass production to mass customization and the ability to manufacture in small batches. To achieve this, it is becoming increasingly important to develop modifiable, extensible, reconfigurable, adaptable and fault-tolerant manufacturing systems. The reconfigurable and flexible manufacturing systems are a solution for these market requirements.

This paper concludes that the Part families are also a pre-requisite for successful flexible manufacturing systems, as they rely on the economy of scope achieved

through capitalizing on similarity in geometry and/or processing, sometimes through the application of group technology.

REFERENCES

1. Mehrabi M.G., Ulsoy A.G., Koren Y. Reconfigurable manufacturing systems: key to future manufacturing. *J Intell Manuf*. 2000; 11: 403–19p.
2. Landers R., Min B.K., Koren Y. Reconfigurable machine tools. *CIRP Ann.* 2001; 49(1): 269–74p.
3. Slack N. The flexibility of manufacturing system. *Int J Oper Prod Mange*. 1987; 7(4): 35–45p.
4. Toni D.E., Tonchia S. Manufacturing flexibility: a literature review. *Int J Prod Res.* 1998; 36(6):587–1617p.
5. ElMaraghy H.A., Kuzgunkaya O., Urbanic J. Manufacturing system configurations complexity. *55th CIRP Ann*. 2005; 54(1): 445–50p.
6. Koren Y., Hu J. Weber timpact of manufacturing system configuration on performance. *CIRP Ann.* 1998; 1: 689–98p.
7. Fujii S., Morita H., Kakino Y., *et al.* Highly productive and reconfigurable manufacturing system. *Proc Pacific Conf Manuf*. 2000; 2: 970–80p.
8. Koren Y., Heisel U., Jovane F., *et al.* Reconfigurable manufacturing systems. *CIRP Ann.*1999; 48(2): 527–40p.
9. Wiendahl H.P. Some remarks on changeability, reconfigurability and flexibility of manufacturing systems. Paradigms of Manufacturing-A Panel Discussion. 3*rd* Conference on Reconfigurable Manufacturing; 2005 May; Ann Arbor, Michigan, USA. 2005.
10. Wiendahl H.P., Scholtissek P. Management and control of complexity in manufacturing. *CIRP Ann*. 1994; 43(2): 533–40p.