THE RMS AND FMS: WHATS THE DIFFERENCE

Dr. VASDEV MALHOTRA*

Abstract:

The ability to handle changes and quickly manage manufacturing and the Production system to compensate for external demands is becoming an important competitive factor. Meeting customer demands requires a high degree of flexibility as well as abilities to reconfigure operations for new demands. Based on literature review, various types of flexibilities are presented with a view to clarify their correspondence. This paper highlighted the merits, demerits and applications of RMS and FMS. This paper also presents the comparisons of RMS and FMS. The paper is concluded with a future research of flexible and reconfigurable manufacturing system.

Keywords:
Reconfigurablity, Manufacturing systems, Flexibility

* Department of Mechanical Engineering, YMCA University of Science and Technology, Faridabad, India

1 Introduction:

In the eighties, the concept of flexible manufacturing was introduced in response to the need for mass customization and for greater responsiveness to changes in products, manufacturing technology and markets. A flexible manufacturing system represents a manufacturing process under computer control to produce a variety of products. According to Kouvelis, et al (1999), the FMS is a group of NC machines tools that can randomly process a group of parts, having an automated material handling and central computer control to dynamically balance resource utilization so that the system can adopt automatically to change its parts production. The FMS is a randomly loaded automated system based on group technology manufacturing linking integrated computer control and a group of machines to automatically produce and handle parts of continuous serial processing. The FMS is made up of hardware and software elements. Hardware elements are visible and tangible such as CNC machines tools, material handling equipments, coordinate measuring machines and computer hardware equipment. Software elements are invisible and intangible such as NC programs, tooling information, CMM program work. However, in the FMS, various problems have encountered both at the technical as well as at the organizational level such as design problems, planning and scheduling problems. The design problems include, for example, determining the app number of machines module of each type, capacity of material handling system. Planning problems includes the determination of the optimal partition of machine tools, plant layout, allocation of fixtures to part types and assessment of operation. The scheduling problems are very complicated. They include determining the optimal input sequence of parts and a optimal sequence at each machine tools. In the nineties, optimality, 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 attempt to achieve changeable functionality and scalable capacity (Koren et al., 1990). It proposes a manufacturing system where machine components or material handling units can be added, removed, modified, or interchanged as needed to respond quickly to changing requirements. Such a fully reconfigurable system does not yet exist today but is the subject of major research efforts around the world, with special emphasis on the hardware and machine control aspects. Proponents of this approach believe that it has the potential to offer a cheaper solution, in the long run, compared to FMS, as it can increase the life and utility of a manufacturing system. Hardware reconfiguration also requires major changes in the software used to control individual machines, complete cells, and systems as well as to plan and control the individual processes and production. The reconfigurable manufacturing system accommodates potential changes in both the operating environment and system objectives creating designs with enhanced performance and eliminating the need for limited design. The modularity, integrability, flexibility, scalability, convertibility, and diagnosability, are the key characteristics of RMS that helps to achieve the desired reduction in time and cost. Section 2 demonstrates the types of flexibilities, components of flexibilities with merits and demerits along with applications of flexible manufacturing system. Section 3 presents the overview of reconfigurable manufacturing system, merits, and demerits along with applications. Section 4 shows the comparisons of RMS and FMS. Section 5 shows the conclusion and future research of flexible and reconfigurable manufacturing systems.

2 Types of Flexibilities

Review of the literature identifies at least 10 types of manufacturing systems flexibilities (Browne et al., 1996). These are as below

1. Machine flexibility: The Various operations performed without set-up change,
2. Material handling flexibility: The number of used paths, total number of possible paths between all machines.
3. Operation Flexibility: The number of different processing plans available for part fabrication,
4. Process Flexibility: The set of part types that can be produced without major set-up changes.
5. Product Flexibility: Ease of introducing products into an existing product mix.
6. Routing Flexibility: The number of feasible routes of all part types/Number of part types,
7. Volume Flexibility: Ability to vary production volume profitably within production capacity,
8. Expansion Flexibility: The ease of augmenting capacity and capability, when needed, through physical changes to the system,
9. Control Program Flexibility: The ability of a system to run virtually uninterrupted due to the availability of intelligent machines and system control software,
10. Production Flexibility: Number of all part types that can be produced without adding major capital equipment.

2.1 Components of flexible manufacturing system:

According to Shore, et al (2000), there are some important components of flexible manufacturing system as follows

1. Pallet and fixtures
2. Machining centers
3. Inspection equipment
4. Chip removal system
5. In process storage inventories
6. Material handling system

Pallet and fixtures:

The functional component which allows for integration of machines, material handling and in process storage is to use palletized parts. The palletized part is a steel disk with slots on surface. These slots are used to fasten the fixture to the pallet.

Machining centers :

The machining center consists of column, workable and tool storage. The machining center has the flexibility in performing many different types of machining operations such as drilling.

Inspection equipment :

Monitoring the quality of operation in a FMS is necessary. This is usually done through

1. Coordinate measuring machine
2. Probing machine center
3. Robots

Chip removal system :

Chips are the piece of metals, which have been removed from work piece. Two methods of removing these from work area are

1 chip conveyor to the collection box

2 An in floor flume system with a centralized collection area.

In process storage inventories:

Due to lack of perfect information, some buffering is needed between the handling system and machine. The buffering of parts is called in process inventories.

Material handling system:

The primary purpose of work handling equipments was to transfer pallet and work piece between the loading and unloading stations .It is now also used top handle tooling and to integrate various forms of storage in to systems

2.2 **Merits of Flexible manufacturing system:**

Following are the derived benefits of FMS

- Reduction of inventories
- Reduction of lead times
- Improved machine utilization
- Reduction of labor times
- Quick and uncompleted reaction to engineering and design changes
- Increased management control over the entire manufacturing process.
- Reduced equipment cost
- Reduced floor space
- High product quality
- Financial benefits

2.3 Demerits of Flexible manufacturing system:

Following are the derived benefits of FMS

- FMS systems are quit expensive.
- It is complex than transfer lines. As every system is different and tailored made, its commissioning and developing takes times
- Highly knowledgeable persons are required.

2.4 Applications of FMS:

The flexible automation is applicable to a variety of manufacturing operations. According to Yang, et al (2002), FMS technology is most widely applied in machining operations. FMS technology combines the capabilities of the transfer lines for high volume low variety work on the one hand and stands alone CNC machines for mid to low volume high variety production on the other.

3 Reconfigurable manufacturing system:

The reconfigurable manufacturing systems are designed for specific range of manufacturing requirements (Rogers et al, 2003).The reconfigurable manufacturing systems are those systems that are designed for rapid change of structure as well as hardware and software components. In other words, the Reconfiguration is the process of changing the current configuration to a new one, which may involve changing the set of processes. .RMS goes beyond the objectives of FMS by permitting the reduction of lead-time for launching new systems and reconfiguring new systems.

3.1 Merits of reconfigurable manufacturing system:

Following are the derived benefits of RMS

- Increased product quality
- Increased product quality
- Reduced time required for product changeover
- Enhanced ease of prototype development
- Reduction of lead-time for launching new manufacturing system.
- Rapid upgrading and quick integration of new process technology

3.2 Demerits of reconfigurable manufacturing system

- Expensive controller
- Difficult integration of machines
- Difficult selection of machine modules
- Difficult measurement for changeability , reconfigurablity and their relationship
- Difficult to prepare model to determine adequate levels of changeability

3.3 Applications of reconfiguration:

Based on literature review, the applications of reconfiguration as follows.

3.3.1 Reconfiguration of manufacturing organization

In the organization, reconfigurablity allows companies to organize and manage production in the best way that rapidly and cost-effectively delivers products to customers (Drucker, P., 1990). The Intra-company organization reconfiguration concerns reconfigurations of organization units inside a company, which may be further classified as the reconfiguration within an organization unit. Reconfigurations within an organization unit are supported by three basic characteristics: self-organization, self-optimization and self-similarity. Self-similarity of reconfigurable structures means to create synergies by having a clear and general goal-orientation.

3.3.2 Reconfigurablity of Information Systems

Reconfigurablity of manufacturing systems can not be achieved if the information platforms are of rigid structures. Intra- and inter-company organization reconfigurations demand sufficient communications and information (Porter, M., 1996).Information platforms also play a critical role in managing information of a variety of product configurations.

4.1 Comparison of RMS and FMS:

According to Cheng , et al (2003), the comparison between RMS and FMS as follows

Table 1 comparison of RMS and FMS

S.N	Reconfigruable manufacturing system	Flexible manufacturing system
1	Functionality and capacity are variable	Functionality and capacities are pre-designed
2	Variable routing between stages	Pre-planned alternate routing between stations.
3	Capacity expansion of identical machines	limited expansion of system hardware
4	Changeable infrastructure	limited infrastructure
5	Process plans alternatives	process plans alternative predetermined
6	Modularity quick change features and stander interfaces.	Versatile, variable number of axes
7	Dedicated but changeable functions	Multi head, multi spindle, multi task, machine.

5 Conclusion:

Present world is changing giving a turbulent business environment. The performance of the manufacturing system is largely dependent on the ability to be flexible as well as being able to reconfigure the system for new demands. FMS addresses an important need and continuous to be part of future manufacturing systems. However, the users are not satisfied with FMS because of variety of problems, including its lack of reconfigurablity. This research paper shows that the RMS is viewed as promising technology because of modular structure and ease of integration can complement other manufacturing system but the RMS requires additional research and developments in certain technologies for example training and education, modular machines. The research area of reconfigurable and flexible manufacturing systems is quite broad and has a number of areas for future research that to develop methodology for evaluation when there is a need for flexibility and reconfigurablity

References:

1 Koren Y, Heisel U, Jovane F, Moriwaki T, Pritschow G, Ulsoy G, Van Brussel H (1999), Reconfigurable manufacturing systems. CIRP magazine 48(2), pp 527–540

2 Maraghy, R, Ulay Y (2007), Reconfigurable manufacturing systems: key to future manufacturing. Journal of intelligent manufacturing, 11(4), pp 403–419

3 Sethi AK, Sethi SP (1990), Flexibility in manufacturing, a survey. International journal of Flexible Manufacturing System, 2(2), pp 82–88

4 Kouvelis, J.P, Moodie C.L (1999), Definition and classification of manufacturing flexibility types and measures. International journal Flexible Manufacturing System 10(3), pp 25–34

5 Drucker, P (1990), The flexibility of manufacturing system, International journal of production research, 7(4), pp 35–45

6 Jackson, Tonchia S (2001), Manufacturing flexibility: a literature review. International journal of production Reasearch, 36(6), pp 58–62

7 Burbidge, T, Yamada S, Vink P (1991), Manufacturing aspects of intelligent machines, Journal of manufacturing systems, 2(1), pp 981–988

8 Fujii, R.P. and Gambrell, C.C., (2000), Analysis of flexible systems, International Journal of Production Research, 5(2), pp 23-28.

9 Rosenblatt, M. J. and Lee, H.L., (1997), Robustness Approach to Facilities Design, International Journal on Production Research, 25(4), pp 479-486.

10 Shore, R. H. and Tompkins, J.A., (2000), Flexible Facilities Design, AIIE Transactions, 12(2), pp 200-205.

11 Yang, T. and Peters, B.A., (2002), Flexible Machine Design for Dynamic and Uncertain systems, European Journal of Operational Research, 10(8), pp 49-64.

12 D'Souza, E ,Benjaafar, S. (2000), Design of integrated systems, Flexible Automation and Intelligent Manufacturing, Proceeding of Ninth International FAIM Conference, pp. 425-427.

13 Cheng, C.H., Chen, Y. (2003), Autonomous intelligent manufacturing systems and its applications, Journal of Industrial Engineering, 31(1), pp. 409-412.

14 Browne, T.L, Lee, G. H., (1996), Reconfigurablity Considerations in the Design of Components and Manufacturing Systems, International Journal of Advanced Manufacturing Technology, 13(5), pp 76-86.

15 Davis, T, Moon, Y.M. and Kota, S., (1994), Design of Reconfigurable Machine Tools, Journal of manufacturing systems, 2 (3), pp. 29-30.

16 Porter, M., (1996), Importance of Machine Tool Design – A Review, Journal of Manufacturing Science and Engineering, 11(9), pp. 13-16

17 Rogers, G. G., Bottaci, L., (2003), Advances in Manufacturing Systems: A New Manufacturing Paradigm, Journal of Intelligent Manufacturing, 8(2), pp.47-56.