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HFMS: A NEW CONCEPT IN THE CONTEXT OF FLEXIBLE MANUFACTURING SYSTEMS

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ABSTRACT

The flexible manufacturing systems (FMSs) are attracting the manufacturing industries for its adoption to meet the challenges imposed by international competition, ever changing customer demands and rapid delivery to market. But, the implementation process of FMS is very difficult task in real sense, especially in developing countries like India. Many barriers inhibit its adoption. Looking into the real life problems in the implementation of FMS; a new concept is proposed in this paper- "humanized flexible manufacturing system" (HFMS). Western and European countries have adopted FMS with its full automatic production components. But availability of abundant human resources in a country like India has forced the Indian researchers to look for alternative form of FMS i.e. HFMS. A survey of Indian industries is also conducted and it is found that most of the Indian industries support this new idea and want to utilize their human resources in the leverage of FMS.

Keywords: FMS; implementation; HFMS; barriers; survey

Introduction

Technical advancement is going on with a rapid pace all throughout the world. Market scenario is changing day by day. Customers want products of new varieties at lowest possible cost and of best quality. Market is affected by shortened product life cycles, technological advancement, international competition and high quality expectations from the customers. Manufacturers of discrete parts face increasing demands for small-to-medium sized lots of customized products, requiring a production process that can provide flexibility as well as economies (Kouvelis, 1991). To cope up with such an environment, it is the time to transit from traditional manufacturing system to advance manufacturing system like FMS.

An FMS typically consists of numerical controlled (NC) machine tools to process parts, automated material handling systems (MHS) to move parts and tools between machines and in and out of centralized storage (in many implementations these are automated storage and retrieval systems), and on-line computer systems to manage and control all operations. The general trend is to move towards FMS that can perform unattended for long hours. Manufacturing companies in Western and European countries have realized the importance of this advance production technology and many of them have implemented it in their organizations with its full

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automatic components.

Although the advancements in automation of flexible manufacturing technology (FMT) may appear to reduce the importance of human element, appropriate human intervention is essential to realize the true benefits of FMT (Maffei and Meredith, 1994). The complexity of these manufacturing systems makes unattended operations ill advised. A number of the companies have recognized the importance of having an operator present in such systems. In a number of cases the intervention prevented a poor quality part from being made. Damage that had the potential to be serious and expensive was averted because of an operator's quick intervention in correcting problems.

Despite immense automation, human intervention is the most decisive in economy and life. Availability of abundant human resources in India has forced the industries to realize the need to develop enormous power to convert this human potential into all-round progress. Human element can not be ignored in a country like India. Whenever the Indian entrepreneurs are advised to adopt robots, AGVs etc. for material handling in their manufacturing units, immediately, a blunt question is boomeranged- why to adopt these costly devices when cheap labor is readily available? This cheap labor doesn't even require the complex algorithms and control techniques which are very much necessary for the operation and control of automatic material handling devices (Raj et al., 2007).

The above question is really irritating but carries sufficient weight in context of Indian manufacturing environment and it has forced the researchers to look for an alternate form of FMS which is suitable to Indian manufacturing industries. The best answer seems to be the humanized flexible manufacturing systems (HFMS) which definitely cares for the human element. This system suggests the use of human element in the weak areas of FMS such as material handling, loading, scheduling and decision making. The concept of HFMS is very well illustrated in the following sections.

Need of FMS

Today, the manufacturing environment is characterized by rapid change thus posing new challenges and problems to the manager of operations (Fry and Smith, 1988). Such rapid changes include drastically shortened product life cycles, higher quality expectation by customers rapidly developing technologies and intense pressure from competitors. In addition, a growing trend has developed toward production in small batches. Confronted with such an environment, manufacturing processes that can adapt to such changes with the least effort is a requirement. As a result, process flexibility is fast becoming a major priority for many organizations. Manufacturers are now faced with the necessity to produce more customized products of higher quality and lower cost within a shorter time frame (Fry and Smith, 1988). Such flexibility can be achieved through the implementation of flexible manufacturing system (FMS).

There is growing consensus that the principal market and technological pressures on manufacturing in the 1990s are complementary and that both "market pull" and "technological push" are forcing international competition towards greater flexibility (De Meyer et al., 1989). Consequently, the adoption of flexible manufacturing systems (FMS) to respond quickly, smoothly and cheaply to as yet unknown changes in product markets and production technology is becoming a recent trend in manufacturing industries.

It is general view that a straight return on investment (ROI) comparison between FMS and dedicated lines is not necessarily the best way to assess the comparative advantages of these systems for investment purposes. If ROI was the only parameter used, then the industries

would be inclined to select dedicated equipment, where as the production engineering people consider that FMS can provide the advantages listed below which are difficult to quantify:

- Better utilization of machines because flexible equipments in FMS have the capability to reduce the change-over time across the variety of products.
- Reduced work-in-process inventory because of minimum queues at loading/unloading stations as well as at each work-station.
- Reduced industrial relations problems because of reduction in direct as well indirect labor.
- Better communication between planning and scheduling systems because of high level of integration.
- Reduced lead times (by 30% - 40%) leads to improved sales.
- Better quality of products leads to customer satisfaction and to better share of market.
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Problems in the Adoption of True FMS

A flexible manufacturing system (FMS) is supposed to help regain competitiveness through improvements in productivity as well as quality. In addition, an FMS, with its ability to respond effectively to changing circumstances, can contribute toward gaining a competitive edge by reducing vulnerability due to demand variations, product mix variations, and technological improvements in production. Yet, despite these potential benefits, the adoption rate of flexible technology has been relatively slow (Rezaie and Ostadi, 2007). A lot of research papers have been studied and it is found that adoption and implementation of FMS is not hustle free. Raj et al., (2007) have provided a detailed list of problems and gap areas in context of different issues related to design and implementation of FMS. They have also identified barriers which significantly inhibit the implementation of FMS. Some of these barriers are as follows:

- Complex operational and control techniques of FMS
- High cost of FMS
- Difficulty in measuring the manufacturing flexibility
- Non-commitment of top management
- Difficulty in use of automated guided vehicles
- Non availability of good vendors
- Cheap labor
- FMS maintenance problems
- Difficulty in handling the scheduling problems of FMS
- Social implications due to retrenchment of employees

The real life problems and gap areas in the research related to implementation of FMS have forced the authors to look for alternative form of FMS which may be feasible in Indian industrial environment and that is HFMS.

The Concept of HFMS

An FMS consists of the different components like machine tools and related equipments, material handling system and computer control system. Machine tools and related equipments are the basic components of FMS for performing various machining operations. These machine tools include CNC machines, flexible special purpose machines, coordinate measuring machines and machine vision systems etc.

Material handling system (MHS) includes automatic guided vehicles (AGVs), automated conveyors, robots etc. for enhancing automation in FMS. Here robots work as the primary material handling devices for picking the components from conveyors/ pallets and placing these components in the machine tools for machining purposes. AGVs work as the secondary material handling devices for picking the parts from centralized loading/unloading station to place them on the pallets/conveyors for their movements to the robots. Different types of algorithms and dispatching strategies are designed and used for integrating and controlling the movements of AGVs, conveyors and robots for proper positioning of parts within the machine tools for their machining. A centralized computer with the integration of an expert system is needed to maintain the supervisory control over all different components of FMS.

The material handling system (MHS) plays a crucial role in flexible manufacturing systems. When inadequately designed, the MHS indeed can interfere severely with the overall performance of the system and lead to substantial losses in productivity and competitiveness, and to unacceptably long lead times (Sujono and Lashkari, 2005). This is the MHS which requires the main attention of researchers and it is the focal point through which the idea of HFMS is originated. Actually, all the three main components of MHS in FMS environment i.e. AGVs, robots and conveyors have been adopted by Western and European countries because of the following reasons:

- There is shortage of manpower in such countries and they want such types of MHS which can perform like human beings.
- These systems are readily available in such countries.
- Vendors are available for their proper supply and integration with other components of FMS e.g. CNC machines and automated inspection systems like CMMs and machine vision systems.
- Maintenance is easy and cheaper because availability of skilled technicians in this area.
- And main reason is that they can afford their high initial and operating cost.

But the scene in a Country like India is Quite Different such as

- At present, there is not even a single manufacturer for robots and AGVs.
- Reliable vendors are not available who can supply and integrate these material handling devices with other components of FMS.
- Maintenance is difficult and very costly because of scarcity of skilled technicians in this area.
- Abundant man power is available.
- High initial and operating cost of automated material handling devices.
- Weight carrying capacity of AGVs and robots is very limited.
- Most of the manufacturing managers argue that when sufficient man power is available,

then, why to opt for these costly automatic material handling devices.

- And the main reason for their low acceptability in Indian environment is that no complex algorithms and dispatching strategies are necessary for the control of human beings as needed in case of robots and AGVs.

In addition to MHS, Human Element May be Utilized in

I. Production monitoring

II. Decision making and problem solving

III. Fixtures and cutting tool design for FMS

IV. In scheduling of orders; although an FMS is very automated, most FMSs operate in dynamic, complex environments. An intelligent and conscientious scheduler who carefully attends to details and changes can make a big difference in the benefits achieved from FMS.

If such is the situation, then, why not to opt for HFMS where the automatic material handling components are replaced with human labor? All the components of FMS are same but complex and costly MHS are replaced with human labor that will pick up the parts from centralized storage to take them to machine tools for their machining. After machining, they may take these parts to inspection area. Whenever the parts are heavy, they may be supplemented with simple mechanical material handling devices.

Justification of HFMS

The main idea behind HFMS is to replace complex automated material handling components with human element and adopting the other components such CNC machines, flexible SPMs, CMMs, CAD/CAM and machine vision systems in the similar way as they used in an FMS. Only delivery of parts to machine tools and other equipments will be through human labor. The human labor is proposed in place of automated material handling devices because of the following reasons:

- Human labor has more flexibility in grasping and moving the variety of parts than AGVs or robots etc.
- Human body parts like hands and fingers help in grasping, lifting and moving the variety of parts which may differ in their size, shape and weight. But, unfortunately, design and development of multi-fingered robots is a remote dream for, even, the most advanced nations at present.
- Human labor is more intelligent than robots and AGVs which are softwired and hardwired-designed by the human elements.
- Decision making capability is more in human beings than in such automated machines.

In short, it is worthless to compare a human element with an automatic machine which is designed and developed by human beings only.

Literature also supports the use of human element in advance manufacturing technologies. Maffei and Meredith (1994) have advocated the importance of human element in the successful implementation of flexible manufacturing technology. They have suggested the following guidelines to the production managers which are instrumental in enhancing the FMT benefits with human intervention:

- Despite the attempt to achieve totally automated processes, operator monitoring is critical in reducing system problems.

- Moving from a traditional shop to an FMT environment requires much more active participation of the operator in problem identification and solving:
  - I. Providing operators with a high degree of autonomy appears to promote increased problem solving and identification.
  - II. Teamwork is more important in an FMT environment than in a traditional shop
- The more the operator is involved and responsible for prove-out of new products, the smoother the operation runs.
- In an FMT environment, a multi-role scheduler who pays close personal attention to monitoring and controlling the schedule can have a more significant impact than in a traditional environment.

Huang and Sakurai(1990) have reported the importance of workers' participation in the implementation process of automation projects. They have observed that for successful adoption, a company needs the support of employees with adequate training, to operate as well as design and select automated equipment. Some researchers like Cordero (1997) and Cardy and Krzystofiak (1991) have discussed that if the workers who know multiple and better working techniques and skills are available, then, major problems in implementation of FMS are solved because such people can understand the system as a whole in less time. It is important to select such workers because they lever the FMS technology. It will be useful to the industry to select workers with high cognitive ability and the ability to follow the instructions. Cognitive ability helps them to understand the expert system and the programming and limitations of FMS. The ability to follow the instructions helps with a systematic approach to programming, setting up and monitoring FMS.

Rao and Deshmukh (1994) have reported that sophisticated FMS/CIMS installations have not been commercially adopted so far in India. They have also cited the example of Maruti Udyog Limited (MUL) that how this public sector company has been able to achieve the strategic goals the co-operation of the employees. This was possible by using a systematic approach to implement the sophisticated technology and giving an active role to the workers.

With the study of literature and having discussion with technical experts, both from industry and academia, the idea of HFMS was generated and was floated in an questionnaire to the Indian industry. It has been found through the survey reports that most of the Indian manufacturing industries want to adopt advance manufacturing techniques like FMS in their plants and at the same time, do not want to retrench their employees. Instead, they want to utilize their man power in the leverage of FMS and have supported this idea of HFMS for their adoption in preference to a true FMS (as shown in Table 1).

Table 1: Response of Indian industries related to HFMS (Extracted from survey report)

S. No.	Related Questions	Average Score*
A	Reduce man power in your manufacturing plant and have complete automatic mass manufacturing system	3.05
B	Reduce man power in your manufacturing plant and have flexible manufacturing system(FMS)	3.07
C	Want to utilize your man power in leverage of automation and have humanized flexible manufacturing system (HFMS)	3.53
D	Continue in conventional manufacturing system	2.7

*: on Likart scale 1 to 5

Conclusion

It may be tempting to think that in a manufacturing system where the technology and production planning systems are automated and running smoothly, human intervention is diminished in importance. However, just the opposite is true; the human element can not be ignored and it is very much essential. While the flexible manufacturing environment is complex and dynamic, automated systems have limitations and problems. Automation, coupled with human intervention and communication in the operations, scheduling and integration of the flexible manufacturing is crucial for achieving the potential benefits of this advanced technology.

Coming to the basic research boosting proverb that *necessity is the mother of invention*, authors have noted the real life problems in the implementation of FMS in Indian industries and have studied their basic requirement in context of FMS. It is found through the survey and discussion with technical experts that Indian industry is very much eager to transit from old and conventional manufacturing system to the flexible technology and at the same they do not want to ignore their human resources also. They are interested to use human element in the leverage of FMS. Keeping into account the basic need of Indian industry, the idea of HFMS is proposed in this article. But, it is just a beginning in a new era and requires a lot research in this area.

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