CHAPTER 2

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2.1 INTRODUCTION

The performance of manufacturing systems under dynamic conditions is dependent on the productive uses of their resources. Published work on the performance analysis of batch manufacturing systems using different approaches are critically reviewed below.

2.2 ANALYSIS OF MANUFACTURING INVENTORY SYSTEMS

The manufacturing inventory systems proposed by Coyle [3], Fig.2.1. was used by Mohapatra and Sharma [9] and Paul H. [18], to illustrate the use of feedback control theory. But this system response as reported had not been very effective for the dynamic conditions. Though there are solutions such as JIT and GT [20-21], but these are cost intensive due to sophisticated material handling systems to be integrated. A new methodology suggested by Twist R.J., [23-28], called stabilised sequence planning lacks the development of strategies, as confirmed by Bernard K K [22-32], for effective manufacturing planning of systems having finite capacity. It is therefore desirable to stabilise manufacturing lead time of the components to be processed in the manufacturing system of known capacity to minimise WIP. Further correct strategies for stabilised sequence planning using event based approach need to be evolved to reduce nonproductive time, manufacturing lead time and other wastage of resources.

2.3 CAPACITY PLANNING

The development of a strategy for capacity planning is becoming essential [33, 34, 39, 40] for the successful operation of any manufacturing system. This strategy comprises of several elements including how much capacity to add, when to add, where to locate the capacity elements and preparation of dynamic schedules [43, 45, 49, 52, 54, 55, 61] using dispatching rules [71, 72, 73] for the optimal performance [69,70].
Fig. 2.1 MANUFACTURING INVENTORY SYSTEM
The work done by earlier researchers in evaluating scheduling rules for different performance levels at different environment is briefly reviewed. The available data in literature are not adequate due to investigators' failing to present the environment of the experiments. This review shows the fact that the results predicted by the earlier investigators lack precision. The effects of scheduling rules depend not only on the criterion chosen but also on the configuration of the manufacturing system. Moreover, it is found that there is a need for the development of a generalised model for dynamic simulation study of manufacturing system.

2.4 RULES FOR SCHEDULING AND SIMULATION OF MANUFACTURING SYSTEMS

Conway[69] who analysed a large number of scheduling rules, concluded that the SIO rule was the best. His main criteria for comparison of the various rules were WIP inventory and component lateness. Elmarghy[71] considered a system of five machines, one load/unload station and two material handling devices and tested four priority rules (SIO, FIFO, RANDOM, FRO). The conclusion was that the SIO rule provided the highest production rate in terms of total number of parts produced as well as the highest utilisation of all workstations.

Conway and Maxwell[70] provided some insight into the scheduling phenomenon. They found that the Shortest Processing Time (SPT) rule in many due-date based environments performed well but it resulted in an increased processing time. The reason for such increase, when applying SPT was that the processing time only was considered for ranking component priority. The chances were more for the half-finished parts waiting at a machine, having a long imminent processing time never to be routed to the next machine, until all the new incoming parts with shorter
processing time were finished. This might produce very late components or even cause blocking or back-logging in poorly regulated systems. This typical problem compels one to try combined scheduling rules. The above details clearly show that the final choice of the scheduling rules must be based on a detailed simulation study of the system.

2.5 DYNAMIC SCHEDULING OF SYSTEMS

The job shop manufacturing system with the facility for processing varieties of components, as suggested by Mellor P[76], Jatinra Gupta and Arun Walveican [77] encountered many scheduling problems. These problems included variations in batch sizes, processing times, inventory levels, WIP etc., Elmaghraby S E and Park A H [78] had analysed the scheduling rules for identical machines. They had suggested that the manufacturing systems (Machines) of different specifications need to be analysed for the dynamic market conditions [78,79] by taking into account urgent and normal orders for optimal performance.

In manufacturing scheduling of FMS for batch processing components [94], the main objective is to ensure that all operations are completed in proper sequence. FMS is a collection of manufacturing equipment, logically organised under a host computer and physically connected by a central transport system. FMS are quite expensive [95] and effort must be made to avoid high investment risks. The dynamic scheduling [96, 97, 98, 99] of FMS need to be studied as suggested by Montazari M and Van Wasenhove [73] to measure the effects of combined scheduling rules emulating the real life operation of FMS through visual interactive graphics [47, 48].

Deterministic flow-shop sequencing problems had received considerable attention [83, 84, 85, 86, 87] over the past two decades. Most of the reported research had been critically reviewed by Conway[69] and Elmaghraby [82]. Most of these studies were based on the assumption that there was no restriction on the intermediate storage (in process inventory,
buffer, bunker etc.). This assumption implies that once a component is completed on a machine, it either goes to the next machine (if the machine is available), or waits in the intermediate storage which is further assumed to be of unlimited capacity. However, as pointed by Reddi and Ramamoorthy [22] as well as Wismer[84], there are many real life situations, where such an assumption is not appropriate. The total manufacturing time is a critical issue in the operation of manufacturing shops. So minimisation of total manufacturing time is very important to operate an FMC efficiently and effectively. Currently FMC has become a major interest [80-82] for low volume, high variety manufacture with low risk in capital investment. Hence, the problem is of sequencing N components on the two-machines FMC with finite-intermediate storage has been taken for study.

2.6 CONCLUDING REMARKS

Several methods and approaches as reviewed above, are not adequate to analyse the total manufacturing system under dynamic conditions. While their models give better solutions for certain environment (which is not clearly presented in the literature), they are not suitable to analyse the complete manufacturing system under varied dynamic conditions. A detailed analysis of manufacturing systems using a generalised simulation model developed will lead to establish optimal performance.

In the next chapter, dynamic analysis of manufacturing systems is presented. These analysis reveal the desired manufacturing rate and the schedules of manufacturing systems to productively cater to the dynamic markets.