**Name of Research Scholar:** Ravindra Kumar
**Supervisor:** Prof. Abid Haleem, Department of Mechanical Engineering, JMI, Delhi
**Cosupervisors:** Prof. S.K. Garg, Prof. Mechanical & Production Engineering Department, DTU, Delhi.
Dr. R.K. Singh, Associate Prof. Mechanical & Production Engineering Department, DTU, Delhi.

**Title:** Analysis and Modeling of Flexible Manufacturing Systems

## ABSTRACT

Due to the revolutionary developments in electronic industries and the changes in political and social environments, the competitiveness in the global market has grown exponentially in the last three decades. This competiveness was no exceptional to the manufacturing industries. The competitive environment in the manufacturing industries attracted the manufacturers to shift their strategy from mechanization to automation.

Over the time, the trend of manufacturing changed from mass production to the mass customization which developed the concept of flexibility in manufacturing system. This resulted to the evolvement of Flexible manufacturing System (FMS). Since the inception of FMS, there has been a continuous exponential growth in this field. Several studies have been reported to nurture the importance of FMS and the researches are analyzing the performance of FMS.

After going through several research papers, the problems related to FMS in different manufacturing scenarios have been identified. It is observed that FMS layout, parts arrival pattern, workload balancing, processing time distribution, scheduling and routing of work-parts, and material handling system are the major issues in FMS. Among these, material handling system is one of the critical issues which can affect its performance critically.

Considering the wide applications of computer simulation tools used in solving the manufacturing related problems, the simulation methodology has been used to analyze several FMS configurations in different manufacturing environments. WITNESS simulation software from Lanner Group used to perform all the simulation related activities including modeling and data collection after the simulation. Taguchi method has been used to reduce the number of experiments without compromising the significance of variables and also used to perform the statistical analysis. Signal-to-noise ratios are used to compare the performance of FMS in different manufacturing environments. The results are found to be important in view to identify the significance of various performance parameters.

A study is performed on the AGV configurations which largely affect the performance of the material handling system in FMS. The AGV issues related to design and scheduling have been described. Based on the features of these AGV configurations, a new model of AGV configuration has been presented to achieve the combined benefits of earlier configurations.

One of the studies involves the analysis of effects of product mix and AGV issues on the performance of an FMS. The results have shown that manufacturing of parts involving different

processing time lowers the overall performance of the system and must be avoided. Therefore, parts must be manufactured in large batch sizes.

Next study is performed to analyze the performance of an imbalanced FMS under different operating conditions. The issues such as buffer capacity at the workstations, processing time of bottleneck workstation, processing time distribution, and parts release control in context of imbalanced FMS have been analyzed. The optimum performance levels of each factor have been identified.

It is observed that larger buffer sizes are not favorable in all the cases of manufacturing and depends on the manufacturing environment of FMS. Processing time distribution also affected the performance and fixed processing time of WSs performs better than other two cases of processing time distributions. It is also observed that parts release control affects the performance of FMS as per the processing characteristics of parts.

Further, the performance of three non-traditional AGV configurations in different manufacturing environments has been compared. The three non-traditional AGV configurations are Single loop, Tandem, and Tandem loop. From the results it is observed that Tandem and Tandem loop configurations have similar performance in most of the manufacturing environments. The average distance/part is however different for these two AGV configurations.

It is again proved that deterministic processing performs better than the variable processing time of parts. It concludes that the AGV speed can affect the performance of the system considerably at different levels of AGV speed.

Thus, it is observed that AGV configuration plays an important role in the performance of an FMS. It is observed that no AGV configuration is ideal under all the operating conditions. Hence, it becomes of prime importance to select a particular AGV configuration under the given operating conditions to achieve the required benefits.