ASSESSING THE IMPACT OF INTEGRATING A MES TO AN ERP SYSTEM

Young B Moon, Varun Bahl
Institute for Manufacturing Enterprises
Department of Mechanical, Aerospace and Manufacturing Engineering
Syracuse University,USA

Keywords: Enterprise Resource Planning (ERP), Manufacturing Execution Systems (MES), Production Lead Time Determination, Simulation.

Abstract: Despite the claims by software vendors on positive values of an integrated MES and ERP system, there has been no systematic study conducted to assess and evaluate the impact of such an integrated system on shop floor operations. This paper presents a simulation study to evaluate the impact of the MES integration with the ERP system on production lead times. First, we describe a methodology of using a discrete event computer simulation to address an inherent problem of the Enterprise Resource Planning (ERP) system of handling uncertainties and unexpected events. Then, simulation study results comparing the performances of a manufacturing system with MES and a manufacturing system without MES are presented. The evaluation metric used in this simulation is the production lead time. However, the results obtained in this study can be expanded to more general situations with different evaluation metrics.

1 INTRODUCTION

The MES system (MESA 1997) is considered as a solution that completes an integrated information system in an entire supply chain by providing real time information on the shop floor to the ERP system. Many benefits obtained from connecting the MES system to the ERP system arise from the synchronization of data and business processes encompassing from the shop floor to the top floor of an enterprise. Indeed large numbers of articles have been published to report the merits of the integrated MES system with the ERP system. However, these articles tend to describe the benefits of MES in a qualitative manner. (Reed 2001: Ake 2003)

In this paper the impact of MES is evaluated quantitatively and systematically. Simulation models have been constructed to compare the performance measures between two systems, one with the MES capabilities and other without MES. The evaluation metric used in this simulation is the production lead time. However, the results obtained in this study can be expanded to a more general situation with different evaluation metrics.

1.1 ERP

The Enterprise Resource Planning (ERP) System (Fortu 2002) is a software system to support and automate the business processes of an enterprise, which spans across various functional departments such as manufacturing, distribution, personnel, project management, payroll, and financials. The ERP systems identify and plan the enterprise-wide resources needed to take, make, and distribute for customer orders.

The implementation and maintenance of the ERP systems is very high, typically ranging between 15 to 50 million dollars. Therefore, the project of implementing an ERP system is typically the biggest single project that an enterprise launches in its lifetime. Despite its high implementation and maintenance cost, the ERP System has become the de facto solution in industry to deploy enterprise-wide information system.

However, the ERP systems have a few serious limitations. First of all, current ERP systems are built for transaction book-keeping purposes as opposed to decision making purposes. Transaction systems are good at monitoring events, but they are not designed to help the decision-making process.

B Moon Y. and Bahl V. (2005).
ASSESSING THE IMPACT OF INTEGRATING A MES TO AN ERP SYSTEM.
In *Proceedings of the Seventh International Conference on Enterprise Information Systems*, pages 300-304
DOI: 10.5220/0002538403000304

Second, the ERP systems are not capable of handling the uncertainties and unexpected events because the original MRP (Materials Requirement Planning) logic is still in core. The MRP system recognizes the differences between independent and dependent demands. Through a simple logic and with aid of a computer, the MRP system can generate a list of material requirements for all the subassemblies and components. However, the simple logic has a couple of strong assumptions: (i) unlimited capacity on the shop floor and (ii) non-stochastic worldview. The capacity assumption is addressed to some degree in the ERP system through a feedback mechanism. Yet, the inability in handling stochastic situations continues in the ERP systems.

Third, even though there are provisions for taking real-time data from shop floor, the ERP system needs additional external systems or devices such as Manufacturing Execution System (MES) to actually monitor and collect real-time data.

1.2 MES

The Manufacturing Execution Systems (MES) provide up-to-the-second critical data about production activities across the factory and supply chain via communications networks. The MES can assist in the decision making processes for an enterprise by providing real time aspects of the entire manufacturing process. The MES accomplishes this task by guiding, initiating, responding to, and reporting on plant activities in real time, by using current and accurate data. The MES can help reducing cycle times, levels of Work in Progress (WIP), data entry time, paperwork and scrap through the improvement in utilization of plant capacity, process control quality, arrangement of plant activities, tracking of orders and customer service. (Choi 2002: Feng 2000)

The MES acts as an interface between the planning level (ERP) and control level (shop floor) by sending critical real time information to plant managers. Overall it helps in integrating the entire supply chain by bringing the shop floor closer to the enterprise which helps the shop floor to become more responsive to the business needs.

2 PROBLEM DEFINITION

The main objective of the research presented in this paper is to assess and evaluate the impact of MES on an enterprise. We start with a Null hypothesis that the MES has no impact on the operations of the enterprise. The alternative hypothesis is that the MES affects the performance by optimizing the resources. On the basis of the simulation models the null hypothesis is tested and the comparative performance measures are used in making the conclusion so as to accept the null hypothesis or not.

Though we have a reasonable conjecture that real time information will make the production system's operation more efficient, we want to quantify these benefits. We analyze this impact of the MES' on an enterprise by simulating two manufacturing systems, one with MES capabilities and the other without MES.

Even though performance measures can be several including cycle time, WIP inventory, resource utilization or others, we focused on the production lead time in our initial study reported here.

3 A METHODOLOGY FOR LEAD TIME DETERMINATION

Before we begin the simulation study, we need to address the problem of the ERP system associated with its non-stochastic nature. Again, we focus on the production lead time in this paper.

The lead time for a product is specified as a fixed, deterministic number in the ERP systems. However, the actual lead time in the shop floor varies significantly due to the variances in individual processing times and a queue in front of a highly utilized workstation. Such variances are modeled in a simulation model and their results are fed back to the ERP system to determine the most appropriate lead times. The procedure employs bi-directional feedback between the non-stochastic ERP system and the discrete event simulation model until a set of converged lead times is determined.

3.1 The Simulation Model

The ERP systems contain much of the manufacturing relevant data, so their databases can serve as data depository for simulation models.

The first step involves feeding the data stored in an ERP system to the pre-built simulation model. The simulation model reflects a rather long-term description of the shop floor. An interface to directly read the data stored in the ERP database has been designed which would result in an automated update of the simulation model. The production data could be read into the simulation model at specific predefined intervals (e.g. hourly, end of the shift, daily, etc). This enables the simulation model to effectively simulate a near "real-time" production environment and to automatically update the necessary data.

The second step requires the incorporation of the current shop floor status into the simulation model. A production data acquisition system can be utilized for this purpose, such as the MES to trace the current state of a shop floor. The necessary input or the company specific strategies are stored in additional databases or ERP database extensions. From an ERP system and/or additional databases connected to the PDA (Production Data Acquisition) system, we extract all the necessary data to update the simulation models.

The third step is to run the simulation model to estimate an expected production lead time. A base model is developed by a simulation expert in advance, which only needs to be populated with up-to-date data from the ERP system and other data from the shop floor. The data included in the simulation model are resources, product orders and parameters, current production state for each order and each resource, shift system and working calendar, and maintenance intervals. The template model can be adapted in special cases to implement additional strategies. A simulation run generates an event list that is finally returned to the ERP system with other relevant data.

3.2 The Iterative Procedure

The feedback routine follows two steps. The initial lead times originally defined in the ERP system for the products are used as a starting point. Based on those initial data, the ERP software would make a MRP run. This schedule is then fed into the simulation software to check the validity of the MRP run in the current shop floor conditions. Ideally the flow times obtained by the simulation software should be close to the initial lead times. If not, changes are required in the parameters of the production schedule.

The first step is at a macro level and involves increasing the lead time by a predetermined amount of time. This is done to take into account an "allowance factor" for delays. The updated lead times are fed into the ERP and another MRP run is then made. If the two lead times are comparable then we conclude that we have reached an optimal schedule.

Otherwise we need to move onto the second step which is at a micro level. It may not be always possible to increase the lead time by more than a certain amount of time because the job should not be finished too late. In such cases we would need to change some other parameters to ensure that the job gets completed near on time. The following factors can be changed:

* Overtime - Machine hours
* Overtime - Labor hours
* Priority for a particular product - Rush Job

The results are automatically fed back into the ERP system. Once the lead times reach the same values from the ERP system and the simulation, they are accepted as realistic lead times.

4 RESULTS

MES's impact on an enterprise is studied with the help of the simulation models developed using ARENA 7.0 software. For comparison purposes, two manufacturing systems are modelled, one with MES capabilities and the other without MES. The results from these two models are compared on the basis of the production lead time.

A basic scenario of a shop floor is simulated using ARENA simulation software. We assume a situation when one of the machines (say a lathe) on the shop floor breaks down. One of the main capabilities of MES is to reroute the parts to other machine to optimize the shop floor resources and reduce the lead time and inventory. To include this capability in the model with MES we reroute the parts through the parallel connected lathe 2 when the lathe 1 breaks down. MES is able to perform this rerouting because of its real time connection with the enterprise level. This timely information about the machine failure generates an optimum route of the parts to optimize the parameters. For analysis we run 10 replication of 1 day length and compare the results of the two simulation models.

After analyzing the comparative performance measures we observe that the cycle times for the MES model are significantly lesser than the normal model (without MES) for each replication which supports the fact that Manufacturing Execution Systems brings improvement on the lead time of the system. Also the queue length or the number of parts waiting for the lathe 1 (failed Lathe) indicates that MES is able to reroute the parts to the other lathe when lathe 1 fails. This capability of MES helps in reducing the WIP inventory & leads to roper resource utilization.

5 CONCLUSION

Based on the comparative performance measures we can safely reject the null hypothesis and conclude that MES plays an important role in reducing the lead time of a manufacturing system. The results show that the production lead time in a system is reduced by more than 60% by including MES solutions in the production system. On the basis of all these results, we conclude that MES makes a significant impact on an enterprise.

Some of the other benefits introduced by MES are reduced WIP inventory and better resource utilization. Using the simulation models we demonstrated that MES has significant potential to impact the supply chain and to make it more efficient. MES forms a critical link between the ERP and shop floor.

The presented research framework and methodology can easily be expanded to more complex manufacturing systems or an entire supply chain. Other performance metrics can be included in the future study.

REFERENCES

Ake, K. 2003. *ERP to MES integration: An integral key to an Effective Supply Chain*, Available in www.entegreat.com.

Choi, B.K & Kim, B.H. 2002. *MES architecture for FMS compatible to ERP*, International Journal of Computer Integrated Manufacturing, 15(3): 274-284.

Feng, S.C. 2000. *Manufacturing Planning and Execution Software Interfaces* .Journal of Manufacturing Systems 19(1): 1-17.

Fortu, T. 2002. *Enterprise Resource Planning – Integration with Automation Systems*, Master's Thesis, Helsinki Institute of Technology, Helsinki, Finland.

MESA 1997. *MES Explained: A High Level Vision* (White Paper).Pittsburgh, PA, MESA international.

Reed, R. 2001. *Aligning the plant floor to the board room.* IIE Solutions.33: 34-47.

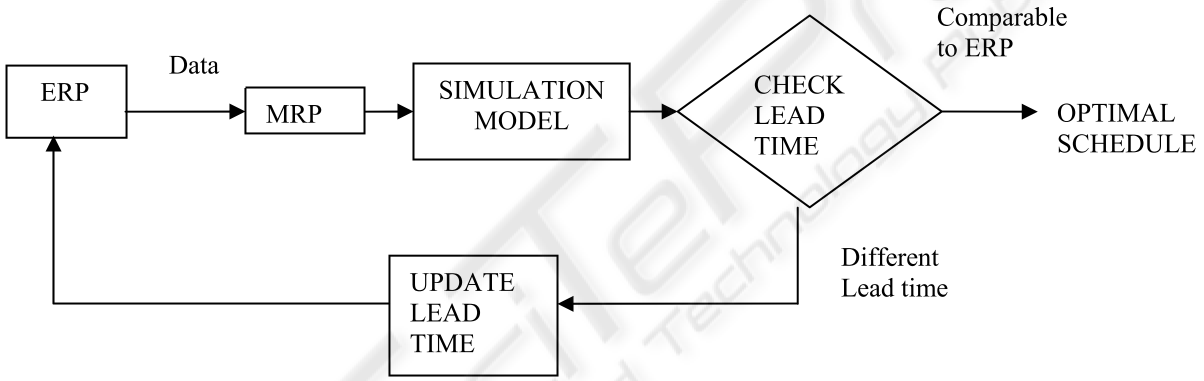

Figure 1: Lead time calculation

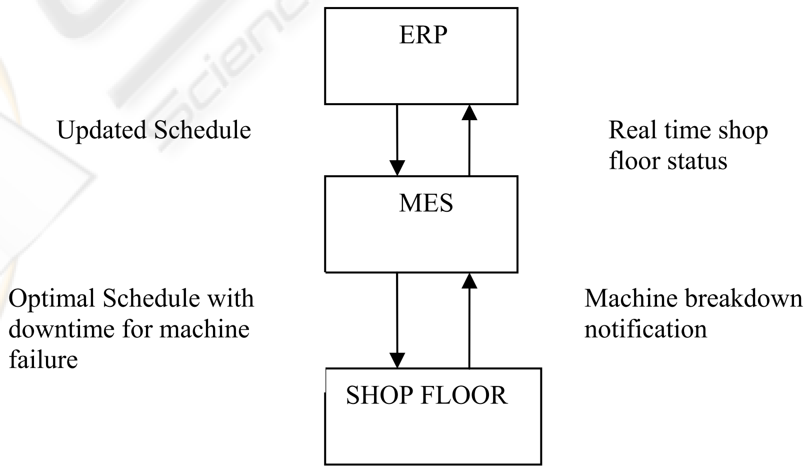

Figure 2: Simulation model with MES capabilities

Table 1: Experimental Results

		Normal Model	MES Model
Cycle Times (in mins.)	Rep. 1	223.74	135.01
	Rep. 2	281.95	111.05
	Rep. 3	223.41	128.41
	Rep. 4	194.36	172.56
	Rep. 5	220.79	177.23
	Rep. 6	236.91	211.29
	Rep. 7	191.91	96.92
	Rep. 8	203.86	146.65
	Rep. 9	161.52	139.32
	Rep. 10	231.68	219.4
Queue Lengths	Assembler	20.58	23.37
	Inspector	0	0.01
	Lathe 2	0.1	0
	Lathe 1	15.93	0.78
Resource Utilization	Assembler	0.84	1
	Inspector	0.54	0.66
	Lathe 2	0.25	0.68
	Lathe 1	0.32	0