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USING SIMULATION FOR SHOP FLOOR CONTROL

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Abstract: There are many issues to be considered in implementing a *Shop Floor Control System*. Overall *Shop Floor Control Systems* are seen more readily as a means of helping waste reduction and competitive performance of the business. The practical exercise in this paper surfaced the need for compatibility of software to be used, the need for flexible hardware interfacing and the need for end-user participation in conceptualizing and developing such a system. The purpose of this study is to explain the philosophy and methods utilized by a small company in using computer simulation to enhance the effectiveness and control of its manufacturing operations. An MRP system feeds the master schedule into the scheduling system for detailed shop floor scheduling. This is used for production control, to monitor and to control production operations. By simulating *Shop Floor Control System*, the manufacturing process is much better controlled, modelled and much more understood than previously. *Shop Floor Control Systems* are seen to offer more than cost reduction and improved production achievement.

Keywords: Computer integrated manufacturing, shop floor control, simulation, MRP, data collection.

1. INTRODUCTION

A major shortcoming of today's manufacturing systems is their ineffectiveness and inefficiency in transmitting data and/or information within and between organizational entities. The effectiveness of an information transmission is demonstrated by its ability to process and to generate the right information. The speed, accuracy and cost of transmission are a measure of its efficiency. Information exists in a variety of forms and for various purposes. A customer order is expressed in the form of information. The perceived need is transformed into conceptual and detail

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product design again expressed as information. The information generated regarding the product design is manipulated and transferred into a process plan. The process plan in turn is transferred into production plans based on information regarding product rates, material requirements, machine loading, demand forecasting, production costs, etc. The manufacturing process involves the transformation into physical shapes to satisfy customer needs. The manufacturing function can be defined as embodiment of information in material, resulting in a product.

The state of the manufacturing system is dynamic. Accessibility and accuracy of data flow are very important for decision making. The more up–to–date the data is, the more accurate or realistic the decision will be. An effective *computer integrated manufacturing* (CIM) *system* requires that manufacturing data be viewed as a corporate resource encompassing manual and computer storage and processing, and that its management must be based upon design methodology. To built an effective shop floor control system we must first understand the system's structure, capture the real system's structure and properties in a model, and then determine causal relationship between input and output by examining the model.

2. SHOP FLOOR CONTROL FOR SEMI–INTEGRATED MANUFACTURING SYSTEMS

2.1. WHAT IS *SEMI–INTEGRATED MANUFACTURING SYSTEM* (S–IMS)?

In developed countries that lead to technology the manufacturing is performed by computer–integrated systems and every kind of information and material flows is controlled via computers. This system conveys the information on manufacturing to the management in time and mutually, it arranges the information flow between management and manufacturing. While the conditions are good liking in developed countries, some works are being done for integrating the manufacturing with computers in developing countries, and the companies are in search of utilization of computers. Not only computers but also manufacturing tools must have some integration characteristics. The large investments are required to adapt CIMS for the companies that have traditional manufacturing tools and are partially out–door dependents in respect to manufacturing technology and this operation takes too much time. Meanwhile, the companies must install and operate the computers to endure firm in competition environment.

Accordingly, the companies in developing countries desire to adapt their traditional manufacturing to CIMS type manufacturing primary use MRP system and manually collect the data belonging to MRP since there were lacks of data collection system, communication between manufacturing and computers and the number of machines. In this case, production control can be made via computers but, an instantaneous shop floor control is impossible. This fact emerges from lack of technical equipment in computer adaptation. It is correct to name this manufacturing system, which computer integration is incomplete semi–integrated manufacturing system. The general structure of this system is given Figure 1.

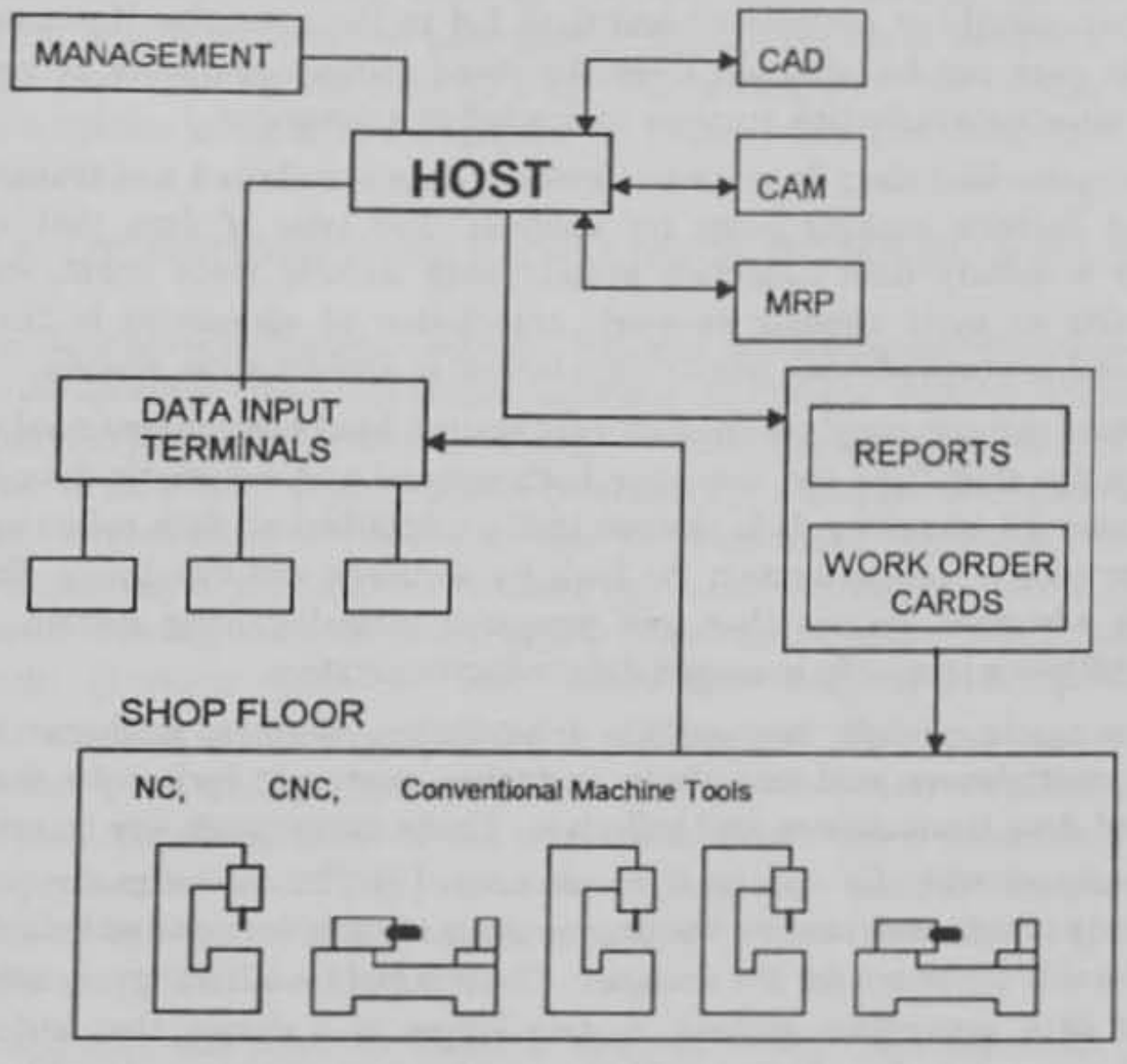

Figure 1. The architecture of S–IMS

The data collection and order data in the companies having S–IMS type manufacturing system are performed manually but, data processing and repeating is done via computers.

2.2. Data Collection System for S–IMS

The most essential components of our S–IMS include data collection elements to receive and collect dynamic data from the shop floor equipment, a simulation model of the shop floor activities, and an interface system that interacts with the data collection elements and the simulation model. Shop floor data collection is very important to gather information regarding not only the system's output but also its status and other relevant statistics such as scrap, breakdowns, etc. This information is needed to close the feedback loop so that various short term and long term planning decisions can be taken. Shop floor data collection is the backbone of a total manufacturing system. It helps monitor and control manufacturing activities on the shop floor. It also provides a detailed status of parts and assemblies that are currently being processed in the shop [1]. The effectiveness of the S–IMS system depends upon the freshness of

dynamic data collection from the shop floor. Accuracy and timeliness of the basic data are important for such systems. In some advanced systems, dynamic data can be collected continuously or periodically and then fed to the computer. In other words, the dynamic data can be obtained manually using human operators or completely automated using data collection systems connected to a computer.

In a computerized shop floor control system, data is collected and transmitted to the relevant decision making point for analysis. The type of data that would be collected by a factory data collection system may include piece count, counts on scrapped parts or parts needing re–work, completion of operations in the routine sequence, machine breakdowns, labour time turned in against a job, and etc.

At present the company' s manufacturing system has both conventional and CNC machines on the shop floor and therefore both manual and automatic data collection procedures may be necessary. It is obvious that a computerised data collection system is preferable over a manual system for both its accuracy and timeliness. But this is much more advanced system than our proposed manufacturing system. For this reason we will use a manually managed data collection system.

Modern machine tools may include transducers, sensors, analogue to digital converters, multiplexors, real time clocks and other electronic devices for the purpose of automated data transmission and collection. These components are assembled into various configurations for process monitoring [5]. In a *computer integrated manufacturing* (CIM) *environment* the organization of such devices and interfaces may pose considerable problems for the designer. These could be of two types, namely data logging and data acquisition system. A data logger is a device that automatically collects and stores data for off–line analysis, i.e. the data can be analysed by a person with or without the aid of computers. On the other hand, the term ±data acquisition system² normally implies a system that collects data for direct communication to a central or host computer. It is therefore called an on–line system [4].

3. USING BATCH TYPE SIMULATION SYSTEM FOR S–IMS SHOP FLOOR

3.1. Batch and On–Line Systems

Data collection in production level is used to transfer information into order control system and to provide current production information to top–management. This data on production must be up–loaded to factory host computer, periodically. This can be accomplished by on–line system in fully integrated plants. In on–line systems, production level data can be transferred by data collection devices. The advantage of this system is always to update current production information. Any changes occurred in the system are reported to the host computer [2]. Factories not having modern production elements such as CNC machines, materials handling system and production networks (LAN) do not need using this kind of on–line system. The solution here is to use batch–type system to transfer collected data to the host

computer. Consequently this process can be done by storing production data in a stand–alone computer or storing them on the order–progress cards manually and then loading them in to host computer periodically. Finally, the plant computer system can not provide real–time information on shop floor status. For this reason, batch–type information system is the most convenient one to Semi–Integrated factories.

3.2. Operations to be Simulated in S–IMS Shop Floor

In the floor level of factories with S–IMS type manufacturing there are CNC and conventional machine tools, materials handling equipment and inspection stations. Rearranging the job routes and rescheduling the floor jobs are required for conveying a seized order to shop floor where various products are manufactured and realizing the production. Therefore order due date can be determined. However, the due date obtained by solving m jobs and n machines problem relatively be correct. During the actual manufacturing, manufacturing break–down due to some reasons and defective manufacture products must be also taken into consideration in determining production size respect to time [6]. In the companies that have not succeeded in manufactured part quality, more realistic control and informing system can be developed with the integration of the imperative break–down mentioned above and defective production size. The order scheduling and possible break–downs are determined using simulation and updating these two factors in terms of job shop data give a realistic solution in a short time.

Consequently the solution found is the one of the best solutions. In modern companies using AGV in material handling operation, vehicle routes and handling time are taken into considered in simulation process while this mode of handling problem is not taken into considered for the companies manufacturing we mentioned above.

3.3. Basic Simulation System for S–IMS Shop Floor Control

The process control from receiving orders to releasing them in S–IMS type manufacturing companies is alone almost by MRP system in that company. The fluctuates in job shop manufacturing are reflected to MRP and the operations concerned with manufacturing resources planning, job scheduling and programming can be done by MRP system used. MRP in management and manufacturing system, partially computer aided engineering operations and planning process are not here integrated thus resulting in fluctuates of data flow and arrangements [3]. Available insufficient integration emerged from lack of equipment in manufacturing level, delay and decreases data flow to management and 'planing, and as a result of this an adequate performance level can not be obtained. Also, management makes a decision not in time because of insufficient data and this results in improductive manufacturing.

In S–IMS type manufacturing, using simulation in job–shop floor control directed to integration of manufacturing and computer can be an effective low–cost solution by adding a few PCs to available equipment and simulation software. The overall framework of S–IMS shop floor control is shown in Figure 2.

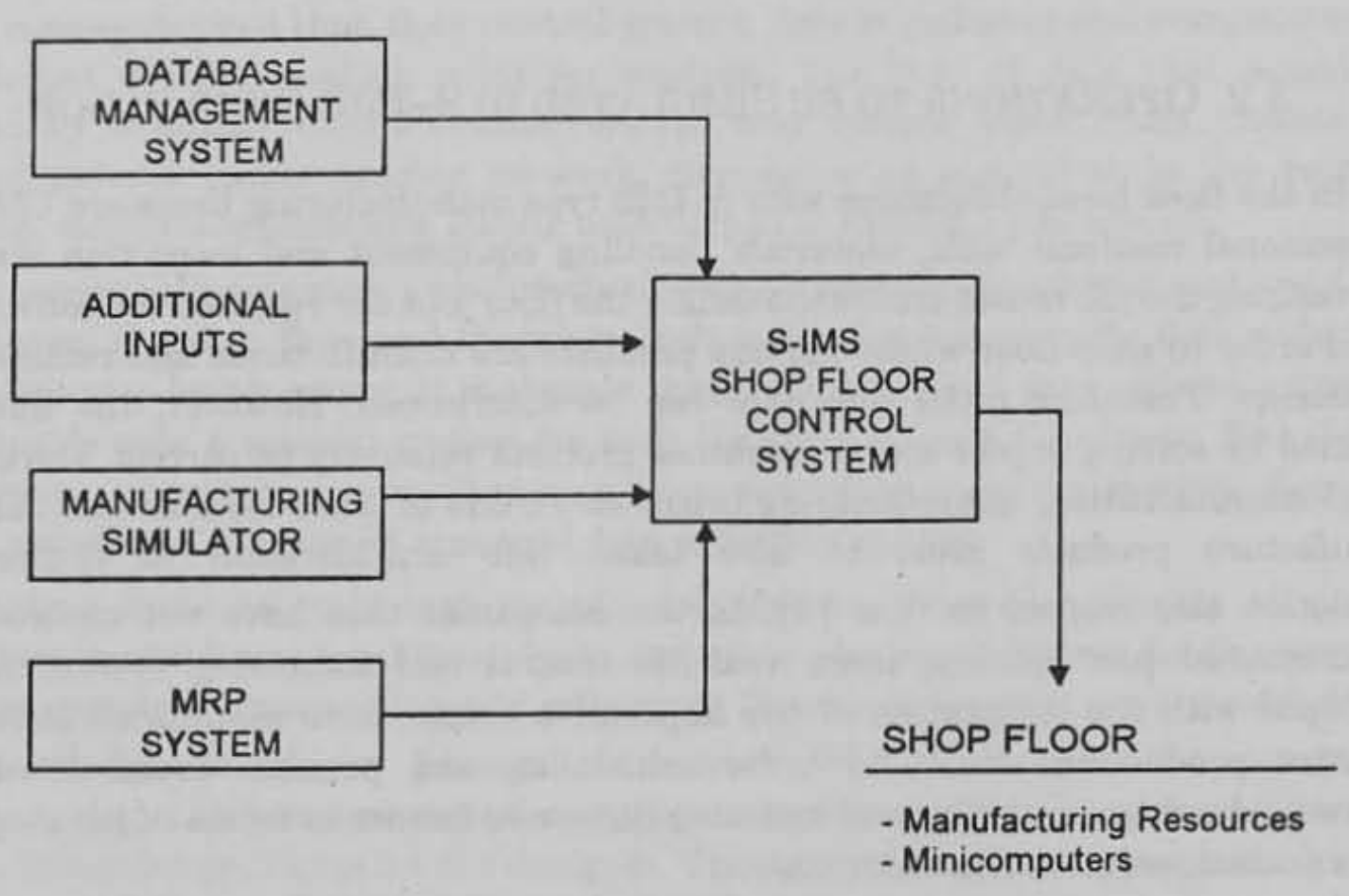

Figure 2. Overall framework of S–IMS shop floor control

Same complex relationships are available among machines and products to present operation sequences since different products are manufactured in shop floor. Uninterrupted manufacturing for productivity involves machines utilized and manufacturing units without break–down. In practice, this is impossible and the manufacturing can be halted by some break–downs occasionally this kind of unexpected manufacturing break–downs, products whose operation sequences are determined are integrated with in–floor job flow, and then controlling and rescheduling these break–downs and products a daily basis as well as using simulation as a tool will lead to increase the manufacturing level control of management and also will provide flexibility enough. The detailed framework of S–IMS control system is given in Figure 3.

Introducing orders to orders module and master manufacturing integration module will bring out a problem of manufacturing schedule, simply integration a new order to manufacturing available. In this case, there will be orders usable and corresponding due dates, on the other hand, there will be an integration of new orders, which can delay or partially affect the manufacturing.

The operations in this stage do not affect the job–shop floor control directly, but they are concerned with it indirectly. MRP module is capable of solving problems

mentioned above. The disadvantage of MRP system in which S–IMS type manufacturing is employed is that this system does not work in real–time. Therefore, while improved MRP softwares are greatly utilized in the integration of new order to manufacturing, they cannot show same performance during the manufacturing because of insufficient data collection. Furthermore, the contribution of MRP system to manufacturing will be expanded by the continuity of simulation study and, using simulation for manufacturing breakdowns and unproductivity in job–shop floor will develop a different sub–system supporting the MRP system.

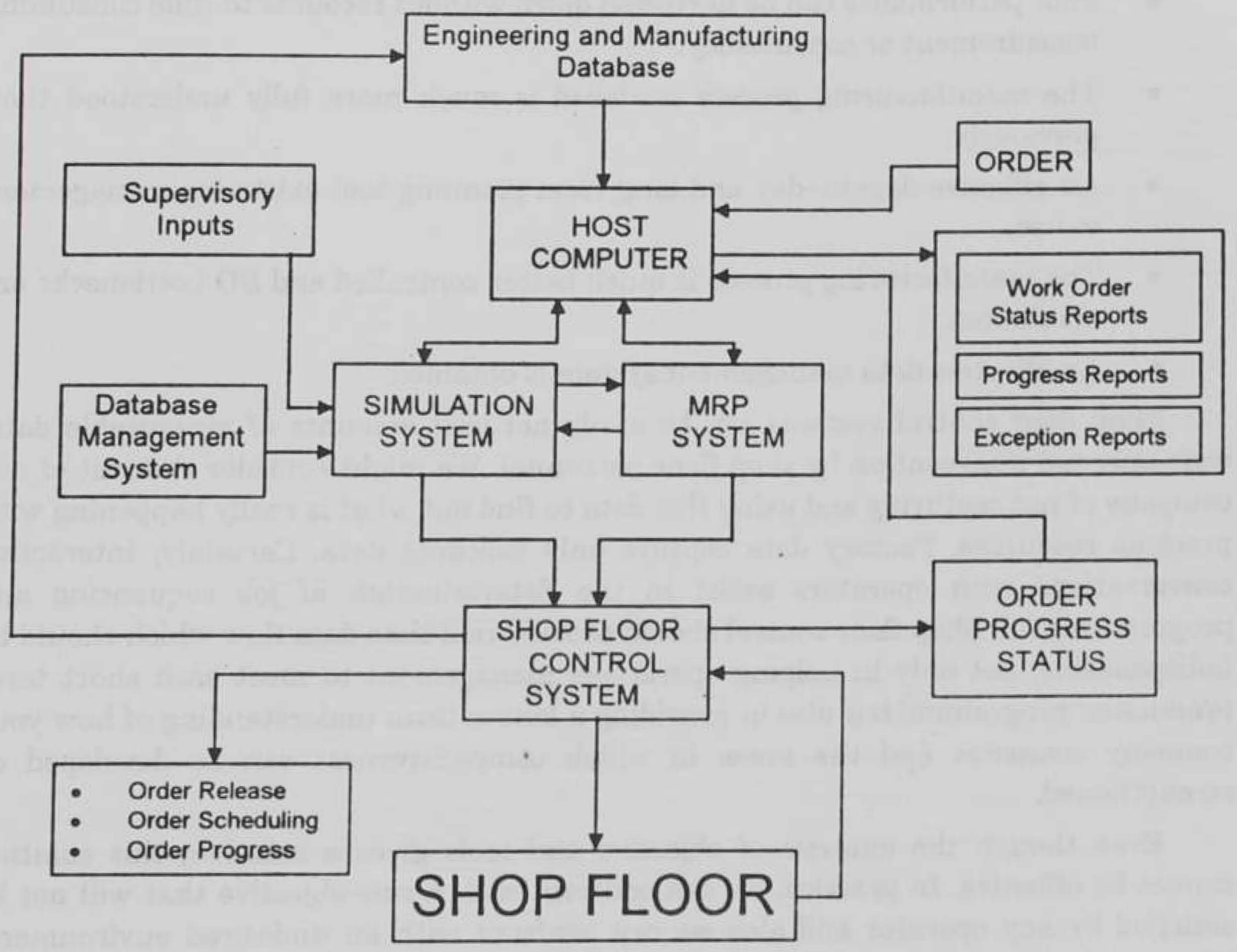

Figure 3. Detailed framework of S–IMS shop floor control system.

Conveying the failures occurring in job–shop floor to master manufacturing module and directly to MRP system will be time–consuming than expected. Again, the need that using simulation module in job–shop floor will emerge.

4. CONCLUSIONS

Simulation uses an accurate model of the manufacturing operation to create a detailed schedule of the activity within the shop floor. A good simulator will consider

the effect of all production constraints simultaneously, rather than separating material requirements and resource capacity. Shop floor control systems must be seen to offer more than cost reduction and improved production achievement. The use of computers in manufacturing industry is going to pervade all aspects of the business. Business computing is mainly about the corporate database, and manipulating that data and this can all be done via computers. The following benefits have occurred either to the implementation process, or to the day–to–day running of the system.

- Failure of one machine does not take out all systems, and some element of disaster recovery is built in.
- Poor performance can be narrowed down without recourse to time consuming measurement or consultancy.
- The manufacturing process modelled is much more fully understood than previously.
- An effective day–to–day and long term planning tool exists for management to use.
- The manufacturing process is much better controlled and I/O bottlenecks are eliminated.
- An effective data management system is obtained.

Shop floor control systems can be easily net vast amounts of measurable data, with minimal intervention by shop floor personnel. We might consider the cost of our company of not capturing and using this data to find out what is really happening with precious resources. Factory data capture only captures data. Certainly, interactive conversations with operators assist in the determination of job sequencing and progress control. Shop floor control should provide real time data flow which should be indispensable, not only in helping operations management to meet each short term production programme but also in providing a longer term understanding of how your company competes and the areas in which competitiveness can be developed or strengthened.

Even though the analysis of objective and tools gives a solution, this solution cannot be effective. In practice, we can confront with a sub–objective that will not be satisfied by any operator and also we can confront with an undesired environment. That is, the fact of realizing a specific sub–objective can violate the original realized objective. We here consider in sub–objectives mutually inter–connected with each other.

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