Manufacturing Management Information Systems Require Simplification

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There is a sense of disappointment in the use of CIM, FMS, MAP, and MRP II as manufacturing management information systems (MMISs). These approaches follow the notion that proper control of the manufacturing process requires a full knowledge of whatever takes place at the plant, always, and at any time. In order to achieve this aim, manufacturing firms usually develop or acquire complex software systems, huge computers and maintain a costly team of computer spectialists and engineers to run the system and keep it up to date.

One of the main causes of failure of these systems is the use of the traditional information systems methodologies, which were developed for financial applications, and which are unsuitable for the manufacturing area. Another source of confusion and misuse, is the lack of specific DSSs and MISs to proper support management decisions for manufacturing organizations.

The difference between MMISs and most financial information systems may be summarized as follows (see also: Ronen and Palley, 1988):

• Managing manufacturing data items is more difficult to manage than it is in the case of financial data items; the problems in the latter case are associated with volume and speed rather than with complexity and large variety, as in the former. Clearing a check is a regular financial procedure in the banking sector. Millions of checks are processed everyday in the virtually the same manner. MMISs, on the other hand, typically manage and control, concurrently, the manufacturing process of hundreds of products, each of which has its own bill of material (BOM) containing a detailed description of its composition. Inventory levels of the various components have to be monitored, missing parts have to be ordered, and the BOMs have to be updated quite frequently with proper version control, to name just a few of many procedures involved in the manufacturing process. In addition, there is a notable and universal trend towards shortening the product life cycle.

The manufacturing system's hardware is much more complicated (CAD/CAM systems, optical readers, programmable controllers, etc.).

• In the manufacturing sector the systems' procedures are, usually, informal.

• People use, operate and maintain their manufacturing systems in a more informal way. They do not have to follow formal and traditional procedures, such as those of the finance sector. People in manufacturing firms also dislike reporting, records keeping and updating the database.

• The formats of information are relatively flexible, and the benefits of information are less tangible.

• Historically, allocation of system development resources has been biased in favour of the financial MISs.

As a result:

• Manufacturing information systems exhibit a relatively high failure rate, compared to financial information systems.

• A high degree of dissatisfaction among the users is evident.

To sum up, MMISs suffer from the following "diseases":

• Large quantities of data and information

• Dynamic data

• A complex and uncertain environment

• Unreliable data

• An informal work environment.

In addition, there exists an unavoidable Manufacturing Management Information Systems Paradox. The comlexity and uncertainty of the industrial environment would appear to necessitate reliance upon large quantities of data to enable proper management of the system.

COMPUTER APPLICATIONS AND INFO SYSTEMS

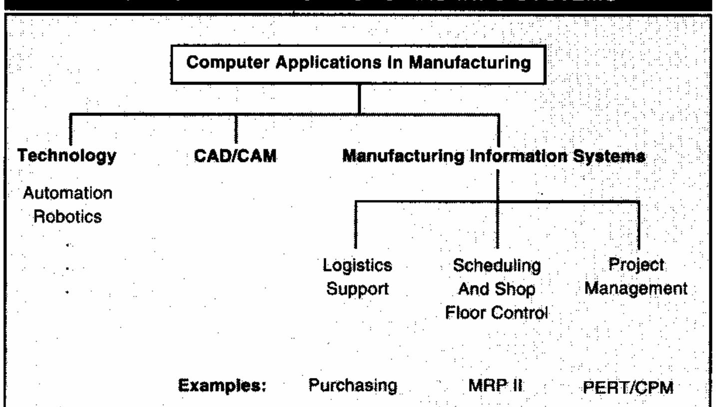

Figure 1

However, the more data you gather and process, the more unreliable it becomes, and at the same time you are burdening your people with excessive reporting, updating, data manipulation and calculations. Much time and effort is spent on counting, reporting and follow-up. Precious management time is wasted on arguments about conflicting data or information delivered by different units. All this results in unreliable and outdated manufacturing information systems, and it forces the manufacturing people to improvise alternative solutions, such as manual information systems, private data files, and independent decision-making practices.

As delineated in Figure 1, computer applications in manufacturing are typically, in the areas of technology, design and management information systems. This article deals only with the managerial realm - depicted on the right-hand side of Figure 1, under the heading of manufacturing information systems. These are further divided into three major parts: logistics support, scheduling and shop floor control, and project management.

Information systems are usually classified into Transaction Processing Systems (TPSs) and Management Information Systems (MISs). MISs may be further divided into Structured Decision Systems (SDSs) and Decision Support Systems (DSSs) (see: Ahituv and Neumann, 1990). The TPSs were introduced in order to enhance the efficiency of the operations sector and to constitute the database of the firm. MISs are intended to support management control as well as the strategic planning activities of management, in an effort to improve the effectiveness of decision making.

Examples of the areas of application for TPSs in manufacturing domain are: order entry, bill of materials and inventory. Examples for MMISs are: shop floor control, aggregate planning, inventory control and cost evaluation.

There is a need for a different methodology for the development and the implemention of manufacturing information systems. The first step should be the simplification of the manufacturing system by implementing production management techniques such as Just-in-Time (JIT), Group Technology (GT), or Synchronized Manufacturing (SM). The system should then be analysed and the MMIS designed accordingly by a manufacturing specialist trained to deal with manufacturing strategies and information systems.

MAPPING MANAGERIAL PHILOSOPHIES

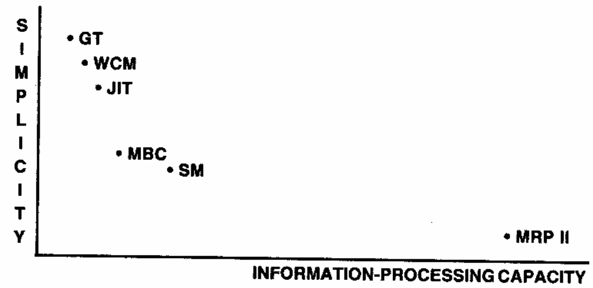

Figure 2

Coping with MMIS problems

The theoretical basis for the trend towards simplicity was laid by Galbraith and by Simon. According to Galbraith (1977) Information Systems (ISs) serve a coordination function in the organization, allowing it to cope with uncertainty and comlexity of both the external and the internal environments. Galbraith starts with the issue of how to organize for a task that will grow in complexity and uncertainty. He suggests two main strategies for dealing with this problem:

1. Reduce the need for information processing;

2. Increase the information system capacity. Warner (1988) elaborates on Galbraith's ideas and indicates several practical mechanisms: 1. *Reduce the needfor information processing by:* a. manage the environment to reduce the amount of uncertainty; b. create slack resources, often in the form of inventory or order backlog; 2. *Increase the information-processing:* a. increase vertical channel capacity in the hierarchy; b. increase the information capacity of selected nodes in the hierarchy (by aggragation, for example).

Simon (1960), in relating to human deficiencies in decision-making, noted three problematic areas: the data problem; the computational problem; and the ranking problem.

Simon observes that people are usually "satisficers" rather than optimizers; hence they set up a level of aspiration and accept the first alternative whose outcome reaches this level.

ISs should work similarly, in an effort to eliminate encounters with the human deficiencies noted above. Using a heuristic that promptly provides a solution (albeit not the optimal one) will be preferred by many decision makers. In other words, Simon's idea comprises a third mechanism for coping with uncertainty and complexity:

3. Do not strive for the best - adopt the "satisficing" strategy.

The first strategy (reduce the need for information) is a component of several management philosophies such as JIT and SM.

The second strategy (increase the capabilities of information-processing) is rarely employed in the area of MMIS. Adopting this approach in a complicated MRP system will not facilitate coping with the ever-changing manufacturing reality.

The third strategy is expressed in philosophies such as Management by Constraints and Group Technology. It can also help the systems designer substantially; instead of developing complex algorithms aimed at reaching optimality, the designer concentrates his efforts on adopting simple heuristics that lead to reasonable and attainable solutions.

In addition to the two mechanisms suggested by Warner (see above) for the reduction of the need of information, we would like to contribute some other effective mechanisms (not in their order of importance):

- strive for decentralization and delegation of authority;
- decouple units - divide a complex plant into simple mini-plants (GT - see below);
- place work-in-process buffers in the appropriate places;
- standardize and adopt similar handling procedures for similar entities;
- manage by exceptions;
- manage by the main issues (e.g. critical paths in the PERT/CPM methodology, A and B items in the ABC classification of inventory, and bottlenecks in synchronized manufacturing);
- strive for simplicity of procedures

and the operation as a whole;

- manage by the buffers;
- manage the system by its constraints; and
- reduce the number of levels in the organizational hierarchy.

Managerial philosophies in manufacturing

Several managerial philosophies have emerged during the last two decades. We shall now discuss their benefits from the information systems standpoint.

The just-in-time system

The Just-in-Time (JIT) system can be divided into BIG JIT and small JIT (Ronen and Starr, 1988). BIG JIT is the philosophy and the strategy, while small JIT is the tactics, dealing with scheduling and control mechanisms.

BIG JIT consists of three parts: TQC - Total Quality Control, TPM - Total Preventive Maintenance, and the JIT production principles.

Total Quality Control (TQC) epitomizes an attitude of on-going improvement of quality. This includes requiring workers to assume responsibility for quality (rather than delegating the responsibility to some central quality control department), instigating line stoppage mechanisms in case of defect detection or occurrence of problems, and quick response to defects in production, with immediate corrective action.

Total Preventive Maintenance (TPM) means giving the workers the responsibility for their machines. Most maintenance procedures are carried out by the worker who operates the machine.

The most important JIT production principles are:

- waste avoidance;
- concistency in revealing problems and solving them;
- reduction of Work-in-Process (WIP); and
- increasing throughput rate.

Working according to JIT principles reduces WIP, cuts lead time, and improves quality. Thus, the smooth operation and low levels of inventory on the floor can reduce the need for information and ease the information requirements.

Small JIT is a scheduling techique, known as the "pull system" or kanban (Schonberger, 1982). This is mainly a non-computerized information system that utilizes manual cards as the means of information transfer and control.

The ideas of BIG JIT apply to any process and any plant. The *kanban* mechanism requires a BIG JIT infrastructure (e.g. reduced complexity) and works best in repetitive assembly lines.

Group technology

The traditional method for organizing factories is "process organization." The alternative method is "product organization," whereby separate lines are dedicated to the production of families of similar products or subproducts. In this way, one simplifies the operation of the plant, clarifies workers' responsibility, and allows faster flow through the plant. Each line is equipped with all the machines and facilities required for the production of a particular family of products. This approach is called Group Technology (GT).

Group technology recommends that the complicated plant be divided into smaller and simpler mini-plants. Here again, as the operation becomes less complex and more managable, the information requirements decrease.

World class manufacturing

World Class Manufacturing (WCM) is the American version of the combination of JIT and GT (Schonberger, 1986; 1987). Its aims at keeping things as simple as possible, shortening lead times, and improving quality. Since the tendency is toward simplicity, one can expect an easing of the information demands.

Material requirement planning

MRP is still the most commonly used MMIS. A full description of MRP can be found in textbooks such as Vollmann et al. (1988) and McLeavey and Narismhan (1985).

No real reduction in information needs can be expected when MRP is used. The contrary is, in fact, true, since MRP is based on the financial philosophy that considers every data item to be equally important.

Many cases have been reported of severe difficulties associates with the use of MRP systems in the plant and they have rarely been used successfully as a scheduling tool or shop floor control tool. In practice, the system is used for the most part in inventory management, bill of material management or calculating net requirements of raw materials. Thus, MRP may be suitable as a database or TPS tool. Problems arise whenever the users consider MRP systems as MMISs rather than TPSs.

Synchronized manufacturing

Synchronized Manufacturing (SM) tackles the problems of shop floor management, suggesting the concentration on the bottlenecks of the plant. According to the SM philosophy, the whole plant can be run by adept management of buffers in front of the bottlenecks, by the separate scheduling of the bottleneck jobs, and by deciding on the proper size of transfer and processing lots.

Since managers in the "SM plant" deal mainly with bottlenecks (which,

THE FOCUS OF EACH MANAGERIAL PHILOSOPHY

METHOD:	FOCUS ON:
PERT/CPM	Critical Path
SM	Bottlenecks
MBC	System's constraints
JIT	Material flow
GT	Families of products
ABC Inventory Control	Important items according to Pareto analysis
MRP	Everything

Table 1

though critical, are not too numerous), and need to pay little attention to the rest of the work stations, which run smoothly for the most part, they have to deal with less management problems and require less information. The philosophy of SM is the basis for the Optimized Production Technology (OPT) software package (Lundrigan, 1986).

Management by constraints

Management by Constraints (MBC) is an enhancement of Synchronized Manufacturing developed by Goldratt as the Theory of Constraints (Goldratt, 1988). Similarly to SM, MBC focuses on the constraints of the manufacturing operation, such as bottlenecks, the market situation, and the supply of certain components or raw materials.

According to this methodology, one has to identify, first, the constraints of the system, and then to decide on how to exploit them and subordinate the whole system to this decision.

Practically, the amount of data needed while adopting this philosophy is reduced enormously.

Mapping managerial philosophies In Figure 2, the various managerial philosophies with regard to their information-processing capacity and the degree of simplification of the complex manufacturing environment are compared.

Implications

• Applications such as Inventory Management or Order Entry require the use of TPSs in order to manage and manipulate all the pertinent details. Information systems that are intended to aid management in the planning and the control phase, such as Cost Estimation and Shop Floor Control, should be of the MMIS type. MMISs concentrate on the essential issues rather than on the details.

The managerial philosophies discussed in this article enable management to concentrate on the main issues by simplifying the process and reducing the need for information. Table 1 shows the focus of each managerial philosophy.

• MMISs should be developed in a two-stage procedure: a. Change the process management by using one or more of the philosophies described above. This includes primarily a change in managerial attitudes and usually requires an organizational change, too. Then, in time, when the new processes have stabilized: b. Computerize the system.

Managing manufacturing data items is more difficult to manage than it is in the case of financial data items; the problems in the latter case are associated with volume and speed rather than with complexity and large variety, as in the former.

• After the simplification has taken place successfully, the development of the MMIS starts. It should be designed to focus on the main issues only. Systems based on GT, JIT or SM, are more successful as shop floor control tools than those based on the MRP II philosophy.

• System analysis and design should be done by a professional well acquainted with the field of manufacturing. It involves, in many cases, introducing a change in the managerial philosophy.

• There should be a fit between the corporate strategy and the philosophy of production management chosen for the running of the plant. Moreover, the computerized MMIS should fit the production management philosophy adopted by the corporate executives.

• To sum up, shop floor control should be carried out in a manner different from the current practice. For example, if a certain process consists of 22 stations, the general attitude today is to build a computerized control information system that will be able to monitor the material flow from each station to the next. The process manager should first design the process according to a production management philosophy such as WCM, JIT or SM. Computerized MMIS may be considered only as a second stage. Instead of monitoring 22 stations, 3-5 issues will have to be taken care of - input and output gates, bottlenecks and the main buffers. This methodology will spare management the present, only-too-prevalent disappointment in the use of MMISs.

• The reservations about the implementation of MISs, designed in the spirit of financial systems, to the manufacturing arena, hald also for MAP (Manufacturing Architecture Protocol). This system is suggested as the communication protocol for the plant (Dwyer and Oannou, 1987); its complexity and the reporting of every last detail of what is happening on the floor has led, not surprisingly, to its limited success.

For further reading

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