# Production Information Systems: Practical Considerations and Concerns For Information Resources Management

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**ABSTRACT**

Integration of technologies and systems is high on MIS agendas. In business environments dependent upon production systems, this integration must also include production information systems. Production systems are becoming more and more information intensive with many systems offering different implications for data collection, data manipulation, and data utilization. Yet, neither production managers nor information resource managers seem to recognize the necessary contribution each has to the other. This paper examines production information systems from the aspect of their implications for information resources management. It illustrates that various production systems produce different information considerations. It concludes that not only production system managers but also information resources mangers have a real and immediate need to understand production information philosophies and structures if the corporation is to select and manage effectively a system best suited to its production and information needs.

## INTRODUCTION

Most new production operation systems are looking toward programmable automation and computer-integrated manufacturing. They rely as much on a dependable information flow as a controlled flow of materials producing information along with products and by-products (see Figure 1). Yet, in a survey conducted by the National Electrical Manufacturers Association, less than 34 percent of surveyed executives were influenced by information considerations in selecting production operating systems [20]. Manufacturers preferred to consider cost, current computer capabilities, training, and effect upon employee's jobs [13].

In another survey, data managers stated that their two top priorities were "aligning Management Information Systems (MIS) with business goals" and "data utilization" [10]. However, these managers also rated "decision support systems" and "CIM" as 16th and 22nd respectively. Somehow, they assumed that computer-supported manufacturing and with it production information systems automatically produced data that could be utilized for achieving business goals. In a 1987 survey seeking to identify key issues in information systems management, factory automation as a new and independent issue was ranked 17th. At the same time, concerns for integrating data processing, office automation, factory automation, and telecommunications fell from third to 10th place in the three years between 1983 and 1986.

Factory automation is beginning to free itself from these general considerations and is fast becoming a major concern for information resources planning. From the 1987 survey, it is clear that factory automation and its accompanying information considerations are now current issues for information resources management (IRM).

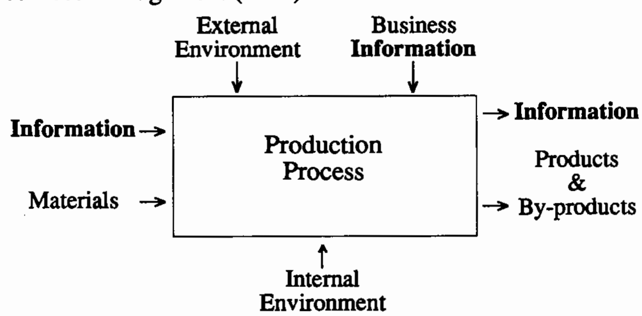


Figure 1, Basic Production System Model

Having said this, it must remain clear that the installation of a particular production operating system is not an intermediate correction. Managers must now rely upon real-time information for statistical and fiscal control in optimizing factory floor processes as they occur. While all proposed new production operating systems claim increased productivity and greater profit margins, the decision to select one system over another may have to be based more upon information considerations than upon pure analytical calculations of net return.

The question is not whether a given production system might be successful in a given environment. Rather, the question becomes one of matching a production system with a set of management considerations, and particularly with a set of information resources management considerations. As is demonstrated in the following, there are significant differences in information considerations among the different production systems. These differences are of direct concern for IRM.

This paper begins with an examination of production information systems from an information resources manager's perspective. Five popular production information system's philosophies and basic structures are discussed: traditional hierarchical production planning and scheduling systems Material Requirements Planning (MRP I) and its extension Manufacturing Systems (FMS). Each system has proven successful in certain production environments, and each demonstrates disadvantages under certain conditions. This is followed by a summary of the implications of these systems for IRM. The questions are not only those of selection, installation and control, but also that of continued operation and growth over the life of the system. If this process is to be successful, then IRM must be informed as well as being a part of management decision making from the very beginning.

### Hierarchical Production and Planning Systems

In the more traditional hierarchical system, formal links are established vertically from the strategic level down to the operational level. Figure 2 (Hierarchical Model) represents a hierarchical system. At the strategic level decisions are made involving policy, capital planning, and longrange development. Decisions at this level assume greatest responsibility for overall system management. The tactical level in a production operation system generally deals with aggregate planning. Medium term decisions and considerations regarding capacity and labor constraints are made at this level. The operational level deals with item decisions, and is assigned a limited decision scope. Each level retains management responsibility and control over the next lower level. Higher level problems can almost always be traced to a lower level. Thus, increasing detail is referred downward (disaggregation), while an increasingly summarized information flow moves upward (informatics).

In a hierarchical model the greatest risk and degree of uncertainty are at the strategic level, while the greatest involvement is at the operational level. For the information resources manager, there must be an appropriate coordination of each decision making level. This can only be successful if information is organized and produced in a manner useful to each level. The information system (both human and technical aspects) must guarantee a report generating system of quality information presented at each level as it flows upward to the next level.

Since each level is expected to react to information from a lower level in a timely and purposeful manner, the information system must be capable of collecting and analyzing large amounts of widely dispersed data. In data systems built upon traditional batch processing considerations, this most often implies summations from one lower level data base to a higher level host data base. Each higher level again further summarizes data from the data base below. What happens in such a reporting/summarizing information system is that details are often lost from sight. While details "a", "b", and "c" in Figure 2 at the operational level may appear insignificant in a summarizing/reporting structure, taken together they can become extremely important for long-range planning at the strategic level. As an example, small shifts in current safety stocks coupled with rare delays in delivery and seemingly insignificant hitches in subcontract negotiations might well signal possible late delivery or even lack of raw products. Yet, since none of these conditions fall outside expected exception parameters, and since they are often the responsibility of different mid-level planning and control operations, they do not appear on the normal summarized reports.

The information system becomes the transmitter of insufficient and often informal feedback. Vital information is lost. The ship continues operation without reacting to submerged problems until they surface, too late for adequate reaction and change of direction.

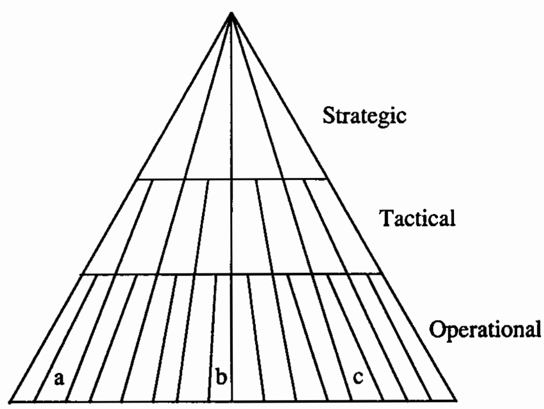


Figure 2, Hierarchical Model

A great many management information systems become increasingly less useful the higher the reporting level because information is part of the organization's history. They summarize to management where the organization has been, but fail to indicate possible futures with any degree of resourcefulness. Thus, in a hierarchical model the information system can become its weakest point. This increases risk at the strategic level and causes strategic management—the apparent ultimate system responsibility level— to fail, and with it, IRM.

### Material Requirements Planning (MRP) and Manufacturing Resources Planning (MRP II)

At the center of a MRP production system is the master production schedule, which can be used as a checklist for selected items planning period. It is an extensive coordinating tool used at the tactical level to track orders throughout a product's entire manufacturing cycle. By formalizing many production practices, MRP is designed to produce timely, accurate information [21]. Production requirements are determined and a bill of materials is developed which details components and labor. From this, goods on hand are inventoried and material requirements determined. Once defined, a MRP schedule permits a situation assessment for planning and scheduling, especially requirements and resource scheduling. Work in progress at each production station is expected to reach a near zero level. MRP automates production paperwork and permits the tactical manager to monitor the production process from purchase order to end product shipment. The result is better planning and control, improved productivity, and reduced paperwork and personnel [1]. For MRP to be successful, it must involve the entire company, and strict schedules must be followed [4].

Material Requirements Planning is in actuality an elaborate information system [2]. As such, it focuses the tactical level manager's attention on accurate record keeping. The guarantor of the system is timely, accurate output data. MRP requires a tremendous amount of data collection to be successful. All too often the quality and power of computer configurations are underestimated and software packages continue to show a lack of integration [21]. Uncertain input data causes rescheduling problems and questions about the use of safety stock and optimal stock levels [7]. Uncertain information about order instability, or "nervousness" [6], causes unstable assumptions in requirements planning, and bottlenecks cause unreliable capacity planning. Thus data, which in any information system must be timely and accurate, tends to become untimely and system generated information fails to provide a reasonably useful situation assessment.

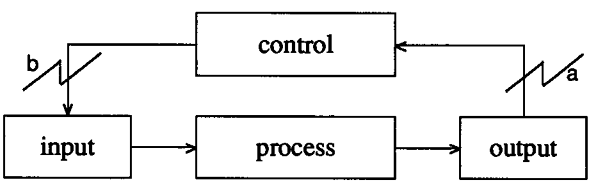

Figure 3, MRP Model

Perhaps the most problematic aspect of MRP for information resources management is the demand by MRP systems that every employee — at whatever stage — "be thoroughly and strictly disciplined about feeding updates into the system" [2]. Tactical managers are **always** to base their decisions upon data generated by the system. MRP cannot tolerate informal systems [3]. And here precisely is the thorn in the bush. In production systems, "informal systems" exist among people who have worked together for years. Many are driving forces within their organizations. Informal systems are quasi-socially based and have little or none of the formal boundaries or communications channels of a formal chain of command and power system [21]. MRP often disrupts accepted informal states and causes managers to feel hampered by the system in their work.

Many tactical level managers feel that MRP, as an elaborate information system, does not respond to their needs, and, consequently, they find ways to work around the inaccuracies which creep into central MRP files. They override the flow of information necessary to operate the system (See points "a" and "b" in Figure 3, MRP Model.) When this happens, the guarantor for a MRP system, its information control driven by timely and accurate output data, fails, and the master production schedule becomes inoperative. The implications for IRM traditionally have been to educate users and maintain data integrity in an open environment. However, the answer will be more than just better data editing routines. It will involve total corporate commitment, lead by IRM.

**Just-in-Time (JIT)**

Japanese kanban, often termed JIT production systems, assigns primary responsibility for production performance to the operational level. JIT assumes that workers are highly motivated and that they perform best when entrusted with responsibility and authority. This not only means making decisions on the line, but also stopping the production line when necessary, and helping others who fall behind [2]. JIT is a demand-pull system, with each sub-assembly pulling parts from supplier departments all the way back to external suppliers. Groups of workers are trained to perform particular operations, and they in turn train other groups [15]. Each person is capable of doing several jobs, often including set ups.

A claim is made that workers enjoy being in charge of a system and making useful operations improvements [2]. Employees working with supervisors are expected to plan operations and make necessary changes, even to the point of performing so well that "...no group of managers, engineers, or planners could have done better" [22]. Failure to perform successfully is "...now viewed as evidence of lackluster planning or controls, even of laziness" [22]. Therefore, management's task would seem to be one of establishing overall goals and providing "...a constant, gradual, and unending improvement in the work place" (or the "kaizen") [14].

A move ticket connects production lines with supplies. JIT expects suppliers to accept rigid delivery schedules and to be responsible for their own quality control. Suppliers are expected to act as extensions of the company itself. The antici-

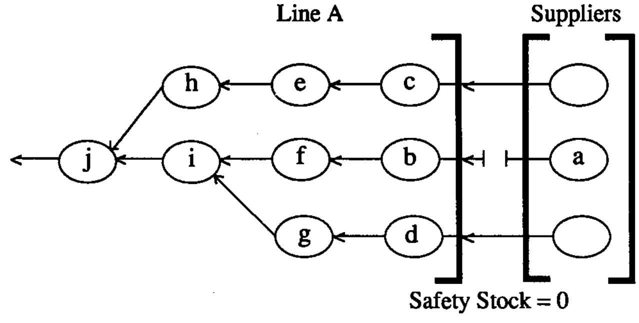

Figure 4, JIT Model

pated result is near-zero inventory levels and greatly reduced product lead times. Should problems occur with suppliers, delivery systems, or raw product quality the system breaks down.

JIT not only is a cultural shock for many manufacturing processes, it affects information as well as materials [8]. To the same extent that production materials planning and control is decentralized, information resources are also decentralized [5]. Functional groups must understand how their actions affect other groups and supply proper feedback and data inputs. Both of these are extremely important in environments of high demand variability, large numbers of end products, problems with suppliers, and low volume operations. Master schedules must also remain relatively stable. If the delivery schedule for supplier "a" in Figure 4 is disrupted and there exists no safety stock, then the workers at node "b" must understand how their decisions will effect others. Will they help at nodes "c" or "b"? Will they move to another line entirely? How will their decisions be communicated to node "f" and "j"? Because a delicate balance is needed between information flow and materials control, JIT systems often require years to achieve optimum results.

There are two basic concerns for information resources management in a JIT environment, and both exist at the operational level. One is internal, the other external to the organization. Internally, should workers fail to perform tasks at expected levels, the system fails critically. This is also true for data responsibility. Workers have an option to manually interrupt product processes or to make immediate line decisions. Yet, even temporary, unexpected manual intervention — unless properly entered into the data system— can lead to incorrect management decisions once an upward integration information process is begun.

Line updates entered by labor become a guarantor for the system. The extent to which management interacts with labor is a sociological question which impacts directly upon the production information system.

Externally, supplier data performance becomes a consideration over which the organization has only long term control. Suppliers exist in the organization's environment as independent entities. There are methods of approaching suppliers [22], but management has in actuality only limited influence over their suppliers, shippers, etc. Since JIT works towards zero inventories, failure to receive timely and accurate supplier information, coupled with low or no safety inventories, can mean failure to deliver end products. A natural disaster to a supplier does not compute in a JIT system. And since JIT is a pull system, when supplier data fails, labor has little option but to fail also; and with it, the information system. IRM must somehow design information systems capable of reporting and reacting both real-time and predictive.

**Proprietary Software: Optimized Production Technology (OPT)**

OPT is an example of a proprietary software package. It was developed by Creative Output Inc. and is sold as a package for managing production operations. Using the philosophy that a plant will not necessarily be maximally productive even if all workers and machines are operating at capacity [19], OPT identifies and eliminates bottlenecks which in turn balances the flow of materials. According to supporters of OPT, the package offers better controls of inventories and work in progress because resources are better utilized [16]. In the process, managers are forced to change old ways of scheduling machines, lunch hours may be staggered to keep bottleneck machines operating constantly, and some workers may be permitted to stand idle when no demand exists for certain components [3]. Many human operational problems are eliminated by design. For the package to be successful, users must accept the entire OPT philosophy and accept its parameters for operation [11]).

For OPT to function satisfactorily, detailed information about each production resource and product network must first be carefully assembled and prepared as start-up data for the system. It is important that the data be accurate right from the start. Once the scheduling module is run, it produces information about critical bottlenecks and schedules the work flow to best optimize inventory and floor resources. The net effect is a balanced production operation.

The heart of this production system is, in effect, information generated by proprietary software developed externally to the organization. It is a package over which IRM has little or no control. Since proprietary software can be relatively expensive ("Buyers must agree to pay an initial fee of at least $2 million, the final price based on an estimated proportion of the savings OPT will generate") [3], management must make an enormous commitment to a process over which its only control would seem to be providing accurate start up data and following resulting schedules. While very good results using proprietary software have been demonstrated for several organizations — especially where large batch sizes and smaller networks are involved — management, at whatever level, has little control over the system; it either produces timely and accurate information or it doesn't.

**Flexible Manufacturing Systems (FMS)**

The FMS is the most information-intensive of all the systems discussed in this paper. Computers and in-house software packages are used to integrate and control production operations as well as floor support operations such as inventory movement, retooling, setups, robots, computerized feeding systems, laser machining, and traveling carts guided by microcomputers. Planning and control systems are literally designed into the system itself. Routine changeovers and management intervention are accomplished by altering programmable software parameters. FMS envisions a production operation in which unskilled as well as skilled labor is no longer necessary and tactical decisions are built into the system. Top level management becomes a systems component and is expected to react in a real-time environment to the flexibility inherent within the system [20] (see Figure 6, FMS Model). Computerization, costing millions of dollars, becomes the key to an organization's production system.

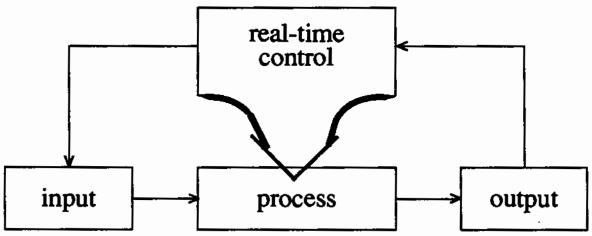


Figure 5, FMS Model

In such an environment, real-time data provided by management information systems and decision support systems, driven by corporate-wide integrated data bases, becomes the actual guarantor of the system. Strategic management is forced to make real-time decisions regarding maximization of goals and operations. But, without satisfactory and resourceful information and without well-defined programmable automation procedures, real-time decisions may mean instant miscalculations. Computer systems have often demonstrated how quickly seemingly simple errors can become exponential headaches. The more complex the information structure, the less likely a simple solution can be found [17]; and the larger the integrated system, the larger the possibility for a network of errors. Because of its complexity, FMS generally do not produce optimal solutions for all production problems. Rather, heuristic procedures are developed which produce good, but not necessarily "the best" solutions [17].

This requires executives who are systems thinkers [20], capable of assuming a management style not readily found in today's organizations. This new manager will be an information person with the information and decision support systems producing the information. In such an environment, the information resources manager will have to be totally involved in corporate planning and decision making.

## Summary

Production operation systems and their accompanying production information systems are becoming more and more interconnected on a real-time level with all aspects of a business organization, including order processing, invoicing, production scheduling, and production and manufacturing. Production information systems are also be coming more and more information-intensive activities. For IRM, this brings challenges that demand an overall information systems planning process. It means that information systems managers will have to understand basic structures and philosophies of many new and varied activities. Hierarchical systems need data base management, accurate summarizing procedures, and good reporting formats. MRP systems require strategic and tactical cooperation to ensure data integrity. JIT systems force sociological considerations of internal and external information sources. OPT systems mean managing proprietary packages, and FMS demand total involvement in all aspects of corporate activities. Information resources managers must help decide what structures are best for their organizations.

Figure 6 (Information Guarantors by Management Level) summarizes a basic set of differences regarding guarantors for the production operation systems reviewed above. Each system not only has different information elements responsible for guaranteeing the correctness of the system, but each system assumes different corporate levels of primary responsibility. Therefore, each system will also have different implications for IRM in design-development/purchase, installation, and operation. Some researchers even support combinations of up to three different production operation systems for one shop [9]. The cumulative effect of this possibility will result in increasing demands for IRM.

**Production Operation Systems**

| Management Levels | FMS | Heir. | OPT | MRP | JIT |
|---|---|---|---|---|---|
| Strat. | real-time information generated by DSS | Information incrementally aggregated at each reporting level | | | |
| Tact. | | | Information generated by a proprietary package | Information from system outputs | |
| Oper. | | | | | Information from line updates and supplier data |

Figure 6, Information Guarantors by Management Level

## Conclusion

Corporate planning is information planning. As can be seen in Figure 6, strategic decisions are inseparably linked to the information systems planning process. It is not merely a matter of deciding which production operation system promises greater net profit. It is also not merely a matter of deciding which system provides a best fit for the type of production operations involved. Along with questions of management style and function, there are matters more philosophical in nature regarding information flow and information structures.

All production operation systems reviewed above have demonstrated successes. Literature cited in this article also contains approaches to solving philosophical problems which surface in varying environments and under varying sociological conditions. Problems are of course bound to be found in any system. Yet, there occurs one theme for all systems reviewed here: the need for production operation systems to control and ensure proper information flow. For IRM, this means understanding production information systems — their weaknesses as well as their strengths. Production information systems reflect a growing number of business structures demanding IRM attention. IRM must be both knowledgeable and involved at all levels if these systems are to be successful.

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