Practical Interactive Systems for Material Requirements Planning

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Interactive Systems can be applied to many computer applications. In the manufacturing environment, the advantages of interactive systems can return great benefits to a company choosing to utilize them. Practical use of interactive systems has been demonstrated in the area of material requirements planning (MRP).

Specifically, this paper will address the materials planning and control function and three application products that HP offers for use on its HP3000 computer. Engineering Data Control, Inventory and Order Status and MRP products provide effective and proven materials planning and control capability for manufacturing companies.

Interactive systems have some inherent benefits over manual or batch systems when used in appropriate areas. (see figure 1). The first of these is the timeliness of data. Some types of information in a manufacturing company have a higher time value than others. When this value is measured in minutes instead of days, an online interactive system where people interact directly with the computer system and their data can provide data on a basis as near to realtime as a human needs.

Because of the terminal-oriented nature of such systems,

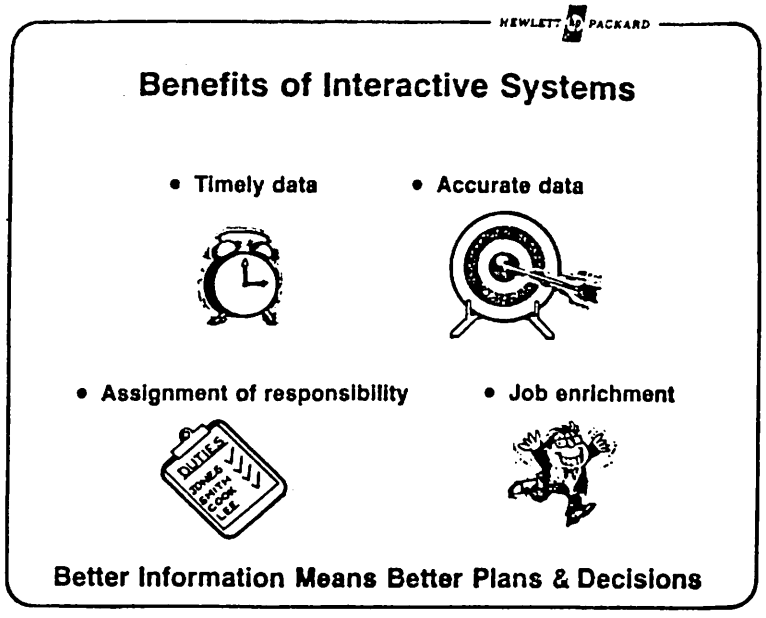

Figure 1.

editing criteria can be applied as the data is entered, and immediate feedback can be given as to the "correctness" of the entry - "garbage in - garbage out" still applies, but much can be done in interactive systems to cut down the "garbage in".

A natural extension to these two points is the "assignment of responsibility". To assign responsibility without the tools or authority to carry it out is useless. An example of this is labor collection. If a lead or foreman is responsible for making sure 8 hours is charged by every employee, don't make him write it down to be transcribed, to be key punched, to be validated and any real and induced errors returned next week; give him an interactive system with its immediate feedback and error correction, then he has both the responsibility and the tools to carry it out.

Lastly, my experience within HP and with many of our customers is that when done correctly, interactive systems contribute to job enrichment rather than detract from it. People want to do a good job, and with interactive systems, they feel much more like a participant. It's really interesting to see people in entry level jobs get excited when asked to explain how their job is helped by the interactive system they use. To sum it all up, the better (timely, accurate, etc.) the information available, the better the plans and decisions which will be made.

The area to which our applications have applied interactive systems is that of manufacturing control. There are three major objectives or pressures in manufacturing control.

On the one hand, there is pressure to minimize investment in inventory (ideally have only WIP and no stores, no FGI), ie.: have vendors deliver straight to production lines and have them ship directly to customers. But the changes in this complex environment probably prevent this.

On the other hand, for customer satisfaction, there's pressure to meet all customer shipment commitments which implies a heavy investment in inventory; to ship on demand that can be unpredictable.

And manufacturing wants to achieve maximum production of a limited staff and keep production lines fully scheduled without stockouts, without line stoppers, and with no idle people.

Balancing these conflicting pressures on inventory is essential to the profitability and success of the business.

Because inventories are so visible to top management, it

is a good place to start when it comes to evaluating the potential contributions computers can make to manufacturing companies.

MRP (Materials Requirements Planning) is the basic priority planning system for keeping production plans current. It's the way by which demand for products(whether master schedule or backlog of customer orders) is brought against supply of parts (on hand and on order) to arrive at a production plan for scheduling orders (work orders or purchase orders). Priority planning indicates what jobs to work on first, second, next, and so on.

Ollie Wight, a leading manufacturing industry consultant puts it very clearly:

> "Priority planning is the key function in production and inventory management. Without effective priority planning, other functions such as scheduling, loading, purchasing, and shop floor control must limp along using largely incorrect information."

There are many benefits to an MRP system, some tangible, some less tangible which, nevertheless, have significant $ implications and are, in fact, the real benefits of MRP:

- Being able to smoothly implement engineering changes over your confidence that you'll have accurate, up-to-date bills of material.
- Being able to predict stockouts will lead to action to ensure that they do not occur.
- Identifying obsolete inventory allows an easy inventory reduction.
- Eliminating line stoppers will keep the production line

fully loaded and productive.

- Knowing 'if' you can meet a master schedule helps eliminate surprises and to take action to ensure that you do meet M.S.
- Meeting delivery commitments results in continued high customer satisfaction.
- Buying in more economic quantities can save you money.

But the sum total of all of the MRP benefits is that a factory can be run with confidence and in a planned mode rather than the chaos that can often exist.

Tangible $ returns are those most often used to justify the purchase or development of an MRP system. In terms of tangible $ benefits, here is how MRP can free working capital for a company.

On a Balance Sheet, MRP will most directly affect an entry like 'Raw Material' inventory or 'Stores' or 'Stockroom' inventory. This is often one of the most significant assets a manufacturing company owns.

For example, a company with $4M of inventory, if it's able to achieve a modest 10% reduction in inventory, can in fact, 'free' $400K per year. Is a 10% reasonable reduction? Many companies have experienced raw material inventory reductions in the range of 15% - 35%.

In terms of profit and loss impact, MRP can help achieve substantial expense reductions. Take the $400K reduction just discussed.

All inventory has carrying cost associated with it--this

includes insurance, taxes, floor space, etc. (15% is a typical charge per $$ of inventory). This 15% represents $60K per year. If the cost of capital were 15%, savings would be an additional $60K. Together, these two figures can amount to $120K of real money to use.

This impacts the P & L statement. It will reduce costs and expenses figure by $120K. This is equivalent to increasing net earnings by $60K. (50% tax bracket) Another way of looking at the impact of the inventory reduction is what increase in sales would it take to achieve the same result.

MFG/3000 is an interactive, friendly, terminal-oriented materials planning and control product from Hewlett-Packard. The product includes many of the things that can make a materials operation more controllable, through its use of interactive terminals.

Engineering Data Control (EDC) contains, as its name implies, engineering data about products, and parts used to build those products, and steps necessary to build products.

Inventory and Order Status (IOS) contains information about quantity of inventory on-hand and on-order.

Materials Requirements Planning (MRP) needs product structure information and lead times from EDC and on-hand, and on-order quantities from IOS to calculate the material plan.

MRP's plan for material procurements, whether it be make or buy, is designed to meet preset inventory level goals while keeping production steady and customer shipments on time. (see figure 2).

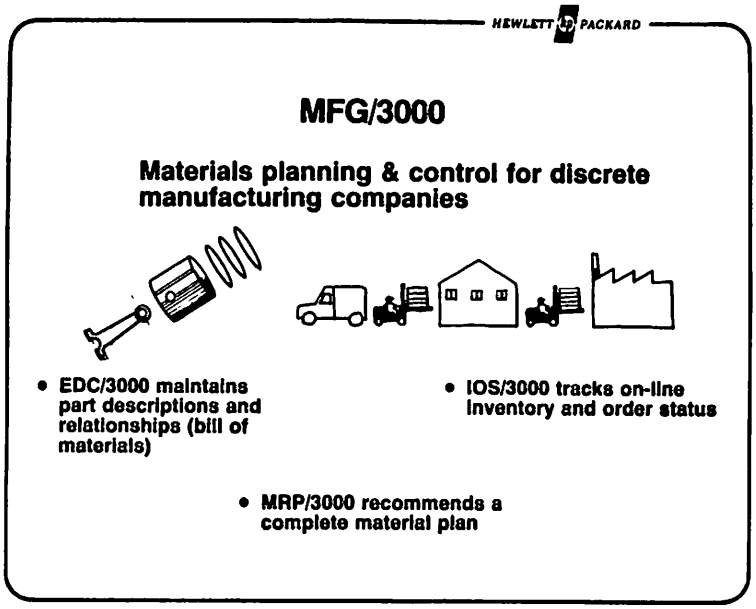

Figure 2.

The EDC product provides a method to standardize documentation for all the parts, products and assemblies a company uses. It allows a straight forward, almost "fill in the blanks" approach to documenting the kind of data that is often associated with parts. It is often known by the name Item Master.

Interactive is a key component of this product, an example of an output screen from our EDC product is included in figure 3.

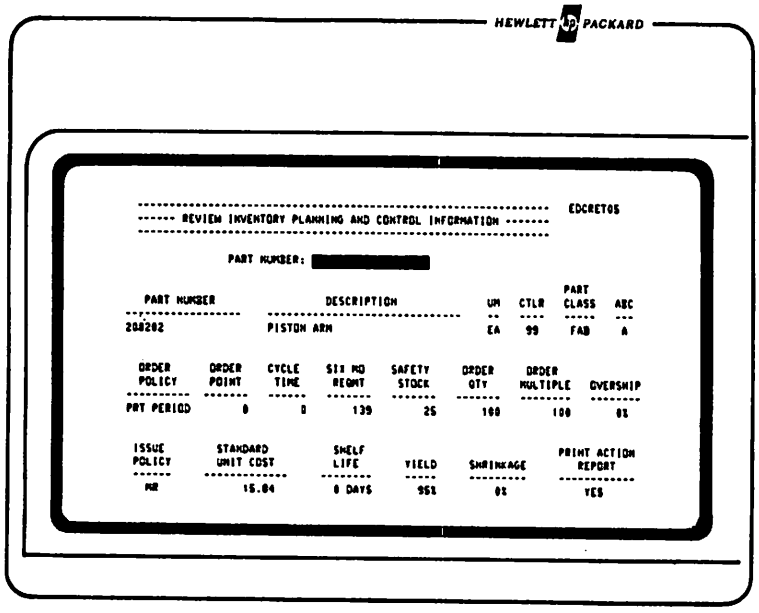

Figure 3.

This figure indicates the type of inventory planning (or we could have used accounting or description) data that is easily available at terminals placed where people need this data.

Once parts, products, and assemblies have been defined, the next task, definition of how these elements combine to make others, can be addressed.

In addition to complete item data on each part, EDC's Standardized Documentation also means that bills of material are all defined and interactive means once documented, bills are available for on-line review.

When it's easy to keep bills up-to-date through on-line data entry and editing, a top manager can realistically set the objective for the organization to not expect any inaccurate bills.

The bill of materials is used to plan, procure, and schedule each item that a plant needs. Errors that get into the system and delayed corrections cause the wrong mix of parts to be purchased or produced resulting in excessive inventories and poor customer service.

Allocations and staging for assembly (and even assembly itself) can be wrong as a result of these errors, forcing an additional workload on the stockrooms, the documentation systems, and rework of the product.

This is a good place to degress and discuss how this product implemented this bill of material.

Throughout MFG/3000, our Datapro award winning IMAGE Data Base Management System was utilized. Through its flexible file

structure data bases and data sets were defined to achieve our result. One important thing about IMAGE is it's companion QUERY, allowing for non-programmer interaction with the data. Ad-hoc or one-time retrievals or reports are handled quickly and easily by operating personnel.

To describe 'friendly' interactive terminals, figure 4 illustrates something called a 'menu'. The menu selection is aimed directly at inexperienced terminal users. It leads them to accomplish their tasks without requiring any written documentation. They need only understand what they wish to do and be able to read and type. In this example, a user who wishes to add a P.O. would 'X' the add P.O. box and hit 'ENTER'.

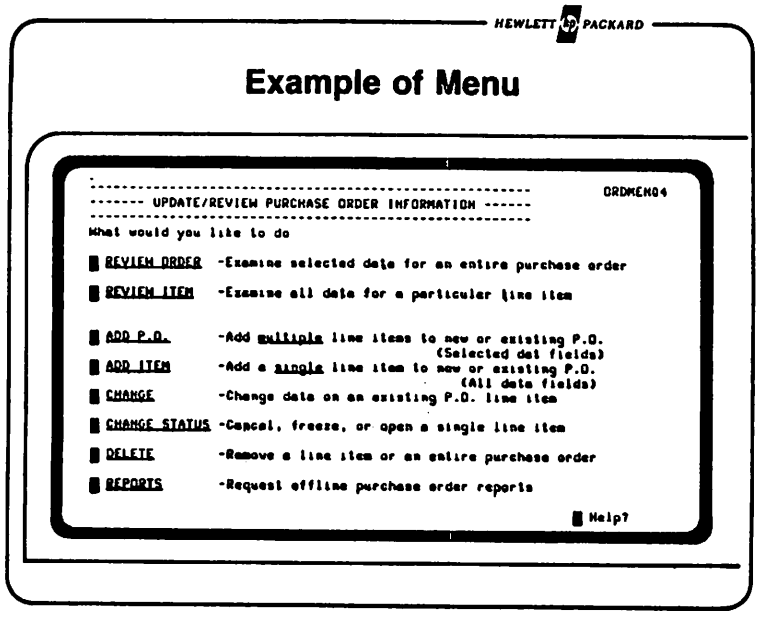

Figure 4.

The 'Help' option offers online documentation where extra explanations are helpful to the inexperienced or infrequent user of the system.

On-line data entry and editing means one can identify and correct the error at the source and not downstream. Since changes to bills can be entered on-line, it's easy to keep them up to date; in sync with how the product is manufactured. All of the data is entered and edited at the terminal, and errors detected immediately and fedback to the operator.

One of the toughest things to control is PCO's (production change orders) or ECN's (engineering change notice). Any system should have a simple and straight-forward way to document changes before they take place and then implement them at the correct time.

Suppose one wanted to change a product to a new, more efficient design; permanently or just for a specific assembly production run. EDC's engineering change facilities gives the capability to enter these changes on-line, days or weeks before the change is effective, and proceed in an orderly manner to implement them. The system allows changes to be controlled by order number as well as date. Not only does the EDC system know about this change, but so will MRP and the production pulling or kitting system.

Phantom assemblies is another key feature of any Bill of Material (BOM) system. EDC's offers two capabilities. On the one hand, it's a way to identify assemblies which are normally consumed on the line (not normally stocked but which sometimes must be stocked due to production overruns, etc.). This assembly will not have workorders planned for it by MRP. It's also a way to switch from one part to a replacement part after

using up all of the old. Code the old part as phantom and when out of stock, MRP will plan orders for its component (i.e., its replacement part). Here again EDC offers a way for your bills to reflect what really happens in production.

These benefits (figure 5) of HP's Engineering Data Control Applications differ from most other packages because of their on-line, east-to-use, "friendly" approack to defining manufacturing parts and relationships. It is designed for use by manufacturing personnel users who have not been trained in 'computerese'.

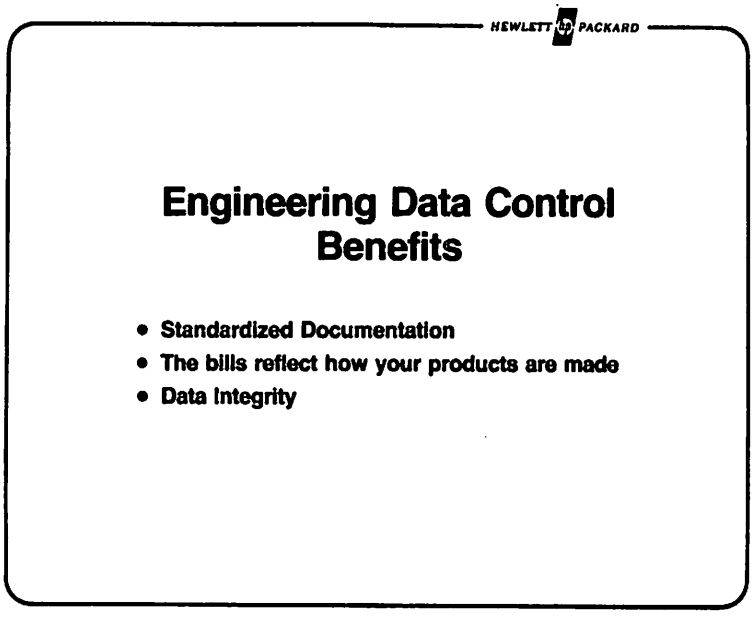

Figure 5.

MRP needs two pieces of information to do its job. Not only the definition of how parts are made from EDC, but the inventory balances of each and every part. This is the role of IOS, the Inventory and Order Status product of MFG/3000.

To control stockroom inventory, one needs to know how many

of each purchased part and assembled part are on-order or in stock. To maintain these balances accurately, an organization needs to be able to:

- Track all issues and receipts
- Track planned issues
- Track planned receipts
- Maintain backorders

and to accurately maintain the relationships between orders and inventory. For example, an order to build a product is a demand on inventory and that inventory can be replenished with a P.O. Any change to an order is probably a change to inventory as well. If a plan is established, issue or receipt discrepancies can be detected and reported.

Accurate, on-hand inventory balances are essential for materials and production planning. The higher the amount of daily activity with parts - receipts and issues - the more important those changes in inventory balances be reflected immediately.

Errors in raw materials inventory records have an impact on fabrication and schedules, causing short lots to be run, or their errors can cause last minute schedule changes, and over capacity production when the necessary material is finally received. Excess inventories are hidden by records showing less on-hand than really exists.

Knowing exactly how many of each part are on hand 'right now' is a formidable question to ask of a manual system or even a batch system. But with IOS, video terminals can be strategically

placed with inventory controllers to answer many aspects of an inventory balance question.

To really know how many of each part are in stock, issues and receipts should be updated on-line and available for on-line review.

Cycle counting is an important capability for inventory control.

The frequent discripancy between physical and book values of materials discovered in the annual physical inventory counts indicate that inventory records don't even represent the average amount of inventory dollars in a plant. Having an annual write-off that exceeds expectations means that profits are mis-stated all year long.

One thing that the industry consultants are in agreement on is that cycle counting produces more accurate inventory records than the annual or semi-annual physical count. Hence accurate profit information can be known throughout the year and steps can be taken through pricing changes or reduced expenses to keep profits at the desired levels.

IOS provides for a two-step cycle counting procedure, i.e. you don't change a good count for a bad count. If the new count differs from the old by more than 10% you are requested to go back and recheck the new count before permanently modifying the records.

Also, inventory counts can be spaced out over time, so that you are managing "counting" with a manageable number of items per day or week.

Purchase orders may be entered and reviewed on-line -- the whole order or any line item during any stage of the P.O. life cycle (see figure 6) from suggestion through receipt. A single P.O. can handle multiple parts and multiple delivery dates per part.

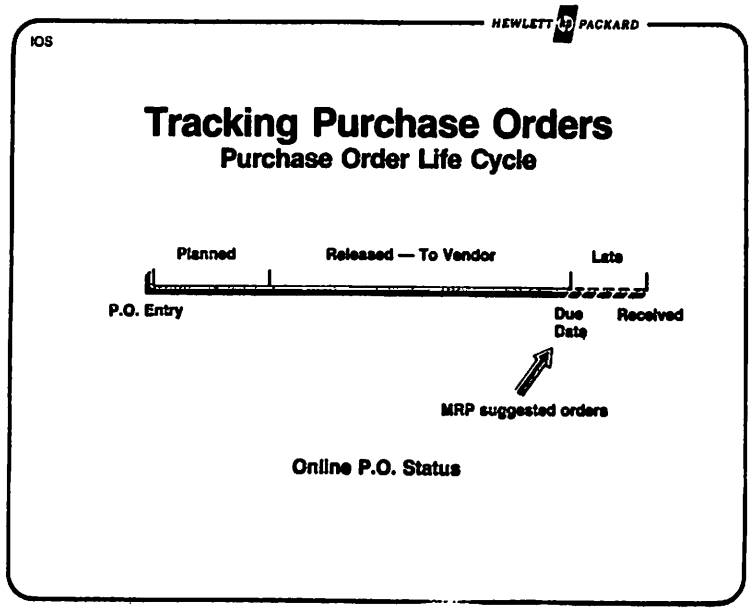

Figure 6.

Since P.O. information is on-line, purchasing can review P.O.'s without digging through paperwork.

When the parts ordered on a P.O. arrive from a vendor, and stockroom personnel key-in the received quantities, multiple copies of a hardcopy material receiver document are printed:

a. one copy can move with the just-received goods, or

b. a copy can be sent to Accounting so that payment is made only for what is received rather than for what has been ordered.

The keyed-in parts and quantities are verified by checking against

the order file, to help eliminate mistakes. The effects of errors caused by misapplying one item to a wrong P.O. can be virtually eliminated by on-line P.O. receipts. Such errors are more difficult to recover from since they involve people outside the company.

The other type of order handled by IOS is a work order; also known as a shop order or manufacturing order.

A work order (see figure 7) is an authorization to build or assemble a specified quantity of a particular item by an MRP calculated due date. The parts necessary to build an assembly will be allocated or 'reserved' to this order. This data comes from EDC's BOM. These reservations will not affect the on-hand balance until the parts are actually pulled.

A daily shortage/pre-shortage report tells which parts for this order would be short if pulled today. The difference is that the problem is identified weeks before it actually occurs -in time to do something about it.

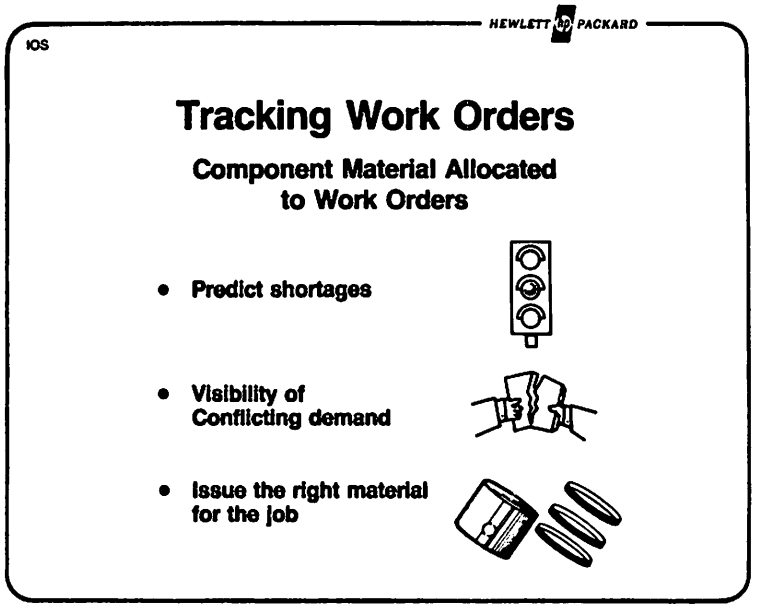

Figure 7.

Allocations indicate how many of each part are RESERVED and how many are available for future or unscheduled demand. Shortages can be predicted.

Allocations also list conflicting demands and give the materials planners the opportunity to choose the higher priority job which should get the parts.

Allocations give control over the issuing process, massaging the allocations can allow tailor making a kit if need be.

Normally, an allocation is satisfied and automatically deleted when stock is pulled from inventory and issued against the allocation. If, however, there is insufficient stock to fully satisfy the requested pull, IOS automatically creates a backorder for the unsatisfied quantity.

When backordered parts are received into ON-HAND stock, a 'backorder fill' document is automatically printed which acts as a tickler and an issue document for the unsatisfied quantities. Multiple backorders for the same part can be prioritized.

In many organizations, materials frequently bypass stockroom records as they are expedited from receiving or fabrication departments, leaving open backorder demand in the storeroom. The demand they indicate has already been satisfied, but the demand records remain causing excessive inventory and distorting true priorities.

A key concern in any environment, and particularly online, is adequate audit trails of data. This product does two things, first, every change affecting information done online is logged

so that if the unthinkable should happen, and the system goes down with loss of data, it can be easily and quickly recovered. A system should not require any re-entry of data to accomplish this and IOS doesn't. Secondly, it is often necessary to retrace the steps taken by your inventory. This is supported with an online retrieval mechanism that can call up all recent inventory activity on a display tube.

In summary, the interactive data entry and update capabilities of IOS insure that time critical transactions are reflected in inventory records.

Latest information retrieval of data on inventory and orders is completely up to date.

MRP (see figure 8) provides the real paybacks from an automated materials system. Although EDC and IOS offer benefits in themselves, MRP puts it all together. Fed by EDC and IOS, MRP suggests a new Material Plan for all parts. MFG's regenerative MRP is typically run once a week.

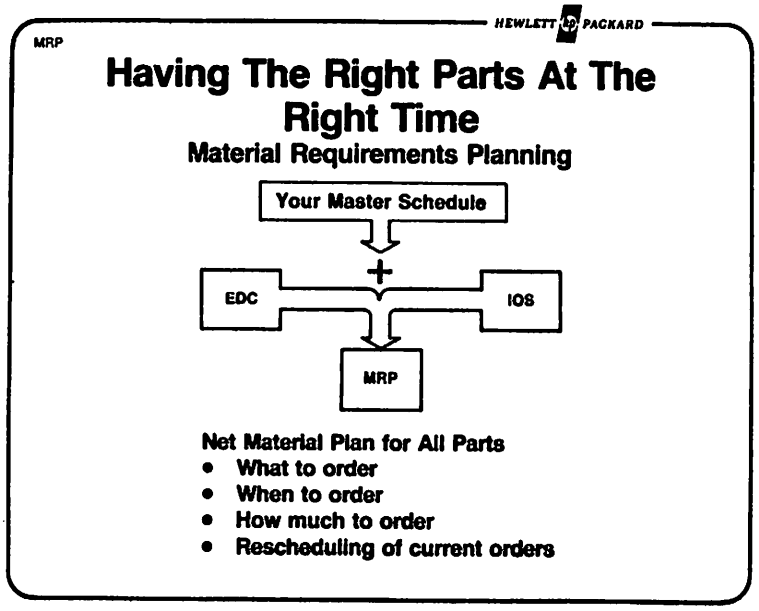

Figure 8.

The essence of MRP is to not order more than what is needed. If one has achieved accurate bills and accurate on-hand records aided by MFG's on-line data entry and editing capabilities, one needn't order more than needed to build the master schedule. A company can, in effect, run lean. This is the goal of MRP -- to drive stockroom inventory as close to zero as deemed safe (i.e., with or without the safety stock as a necessary cushion).

The recommendation of a periodic new material plan means manufacturing lines will have the right parts at the right time and the rescheduling benefit of MRP helps to keep the production plan current so that the right jobs are always being worked on.

MRP runs a master schedule against the BOM to find out how many of each component part is necessary to meet the schedule. Then MRP matches gross demand against on-hand and on-order supply recorded in IOS. Net requirements for each part are calculated along with need dates. Requirements are lot sized according to selected algorithms and using the average lead times stored in the item data file, the need dates are backed off to arrive at a run start date. This production span is matched against the shop calendar, establishing a material requirements plan and creating reports which allow good production planning.

Exception Reports are the starting point for buyer and scheduler ordering activity. There is no need to look at things going according to plan. New P.O.'s and W.O.'s must be reviewed by each inventory planner.

The nature of MRP as a priority planning system is 're-scheduling' (i.e., scheduling and rescheduling), keeping the production plan current.

The MRP Exception Reports recommend order actions (push-outs, pullups, cancellations) which should be reviewed by each controller for their validity. If human judgment agrees, an MRP generated transaction file can update or cancel these due dates on existing orders on the IOS data base.

There are situations where MRP recognizes deviations from the current situation to the current production plan.

The Order Planning Policy is determined by the controller for each part and can be chosen from among six. For example,

- Lot-for-lot -- separate orders are suggested to fulfill each requirement for a part.
- Day of supply -- orders are suggested based on a fixed number of days of demand. The number of days used is based on the ABC classification of the part. For example, "A" parts may have less days of supply than "C" parts.
- Fixed order quantity -- orders are suggested based on the fixed order quantity specified in EDC.
- Part period balancing -- orders are suggested based on the theory of dynamic economic order quantity of least total cost.

The key here is that the individual requirements of each part can be met with MRP; part period balancing for a purchased part and lot for lot a unique subassembly.

There may be situations where a planner would deliberately

want to override MRP's ability to 'keep the production plan' current. The vehicle for doing this is the "Firm Planned Order". It tells MRP that no matter what new due date is calculated for this order, leave it where it is now.

This technique can be used to level the work load in the shop or to change the average lead time for production of a part. This is helpful if subcontracting is planned and it will take longer than the average lead time.

Another good use for this technique is as a scheduler for a critical component, inflating the demand for component parts prior to the master scheduler increasing the master schedule for a big customer order not yet in house to cover a potential shortage.

Another element of 'keeping the production plan current' means being able to plan for parts as far into the future as you have any scheduled demand. MRP's five year planning horizon is essentially an unlimited planning horizon for most manufacturers.

A byproduct of this integrity of orders is a single level pegging so that one can see exactly where a particular item of demand is coming from. This also tells who to alert if delivery dates may not be met.

MRP's benefits are widely know. They include 'having the right parts at the right time', and 'keeping the Production Plan current'.

In addition, MRP teamed up with IOS and EDC can provide those business benefits that are really important; those of inventory, customer service and oeprating efficiency shown in figure 9.

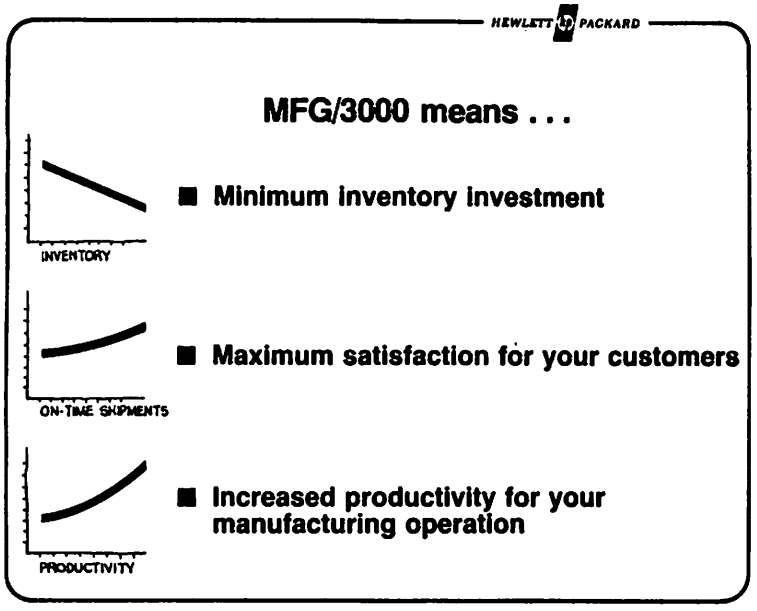

Figure 9.

Some of the aspects that are necessary to define a quality product, whether purchased or developed, are its ease of use, its supportability, and its flexibility. MFG is certainly online and friendly, but its also a standard product, meaning it comes complete with transaction layouts, screen designs, data base specifications and the like. This allows support of the product at the same level as an operating system. But, it is also very flexible. Most of the uniqueness in systems is input and output, not logic. So, many of the input and outputs can be changed to suit specific needs. And since its built on IMAGE, reports are available via QUERY or any one of several computer languages. The benefits of a standard package is not the major subject, but saving time and money in development and maintenance are certainly two of them.

It takes more than just software to make a successful

application product. Availability of full support and complete documentation for these applications is also a pre-requisite.

Training materials for both user and more technical personnel and consulting should also be available for the application.

Customer successes prove that interactive approaches to MRP really do work, and achieve results.

A small, West Coast company which manufactures motorcycle fairings, saddle bags, and other accessories was experiencing a high percentage of stockouts on their purchased and fabricated parts with their manual system. Their manual records were inadequate so the actual percentages couldn't be calculated. In fact, the problems were so critical that they planned for a 120% over capacity for 'makeup' production when the missing parts were finally expedited. As an example of how critical this problem really was, at one point in time, 40% of FGI had no outstanding orders (i.e., they weren't making the right things) and only 17% of FGI was immediately shippable.

This was the situation that prompted management to decide to implement MFG/3000 over a period of just four months. EDC was implemented in one month, IOS in one month, MRP in two months. The results achieved are shown in figure 10, on the following page.

There are two key items there management like best about MFG/3000:

a. The shortage/pre-shortage reports is largely responsible for the 'almost' 'no stockouts' situation.

b. MFG's standard products required no additional DP staff.

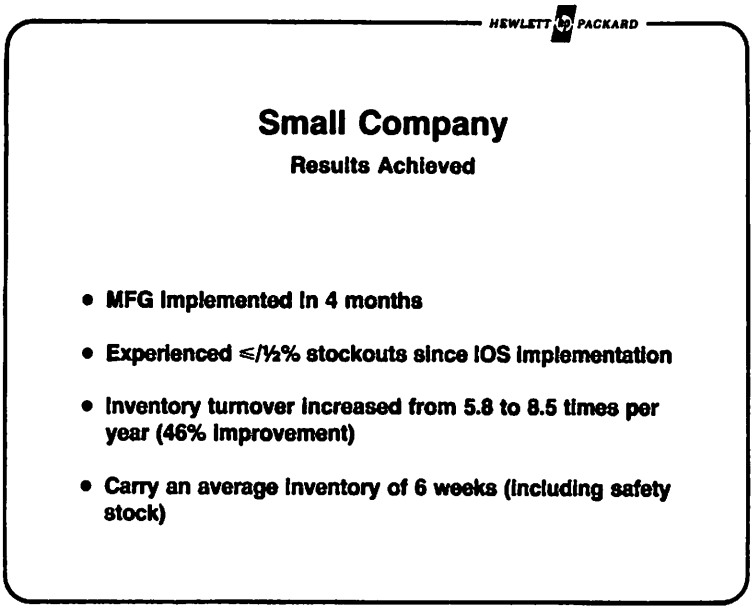

Figure 10.

A second customer, larger is size, has also achieved outstanding operating results with MFG. They are a rapidly growing (100% per year) manufacturer of electronic equipment, located in New Jersey. Prior to MFG they had computerized bills of material, but a manual kardex for inventory control. It took 2 weeks to react to master schedule changes, giving them low confidence in their customer delivery promises. Also, growing at this rate, they needed cash.

MFG was implemented in 6 1/2 months and since their association with MFG/3000, their sales have doubled, but they have experienced the results listed in figure 11, on the following page.

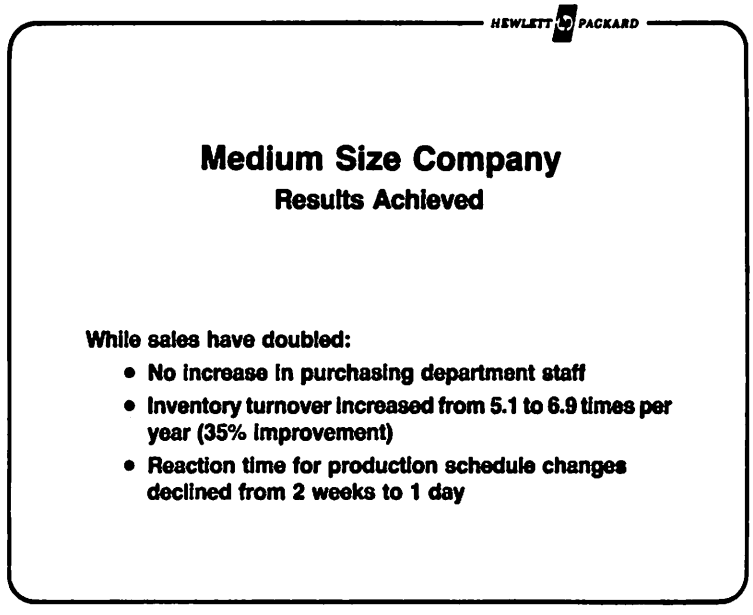

Figure 11.

Interactive MRP systems are working for some companies and these systems are infinitely practical and available.


HEWLETT hp PACKARD