MANUFACTURING CONTROL, PLANNING AND FEEDBACK IN A DISTRIBUTED PROCESSING ENVIRONMENT

By: Mick Belcham
Martin Marietta Data Systems

For a multi-plant manufacturing company the decision to implement a Distributed Processing environment is obviously important. However, it only really becomes significant if the company's management team is capable of recognizing and implementing the associated required changes in management practice and control.

Here I am not referring as much to data processing management as I am to the company's operations management -- those that control what each plant manufactures and the resources required to do so -- money, people, plant, inventory, etc. To them, the decision is not so much one of Distributed Processing, not even one of Distributed Systems, but more importantly one of Distributed Management Control. It is the formalizing of the levels of responsibility (and hopefully, authority) that each autonomous production facility has in establishing what it makes and when it makes it.

Let's take as an example a company that manufactures power tools and other related equipment.

For the sake of the example let us assume that its headquarters and its major final assembly operations are in the Chicago vicinity and that over the years it has grown and built other manufacturing facilities in the Mid-west and more recently in two of the Southern states. To date it has done little to change management policies to reflect this multi-plant situation -- certainly nothing to take advantage of this "distributed manufacturing" environment. All it has seen has been the increased complexity of making shipment schedules from the main assembly plant when much of what is shipped is dependent upon the performance of remote fabrication and sub-assembly plants; plants that suffer not only from being managed independently of the main plant but also from being "buffered" from the shipment schedule by inter-plant transportation problems.

What has it tried to do? The same thing that all of us would do if we were to go after the symptoms and not the cause. It has attempted to tighten centralized control over the remote plants. Just as it was getting used to the idea of "distributed manufacturing" -- even dreaming of installing small computers at each plant site! -- it has had to reverse its posture and make each plant more (rather than less) dependent upon centralized schedules. All plans for remote computer sites have been forgotten, the central computer has been upgraded and the old system (originally designed to support a single plant environment) has been significantly modified to fit the new ideology.

And how have things improved? . . . you guessed it. They haven't. If anything they are worse. They can't even rely upon the "goodwill" of the remote plants any more. Everybody is blaming everybody else. There is even talk at the main assembly plant of <u>purchasing</u> some of those parts previously fabricated at one of the plants. "How else can we meet schedules? At least we will have a better chance of getting what we want when we want when we want it from an 'outside vendor'." Et cetera, et cetera, et cetera.

What was their mistake? Blindness. Blindness to the basics of all good management practice -- accountability and insulation. Accountability for one's own performance, insulation against everybody else's.

They simply went half way. Each plant was theoretically held accountable for its inventory levels, its production efficiencies and its ability to satisfy the main plant's requirements. The fact was however that each of these factors was more dependent upon the abilities of the main plant to assemble to a reasonably-stable production schedule that it was upon the quality of management control at the remote plant itself. Accountability without insulation.

Before examining the impacts of this scenario (and many like it) upon the requirements of a Distributed Processing environment let us take it one step further; take it to its eventual almost suicidal conclusion (all in the name of good traditional management practice, mind you!).

It had to go this one further step before the company's management could be jolted into asking the question that it should have asked all along, "How do I have to change my management philosphies in a distributed manufacturing environment? And what should be my information control mechanisms to support it?".

What was this one final step. Well, think about it? What would you do? Your company's falling apart by all accounts. You still make the highest quality power tools in the business, your company name is as well known as ever in the retail market place, etc,

etc. However two problems are demanding more and more of your time -- manufacturing costs are rising alarmingly and your distributors are complaining increasingly about your shipment performance.

You have done all you can to upgrade your control mechanisms -- in fact, in the last three years you've doubled the size of your data processing department to improve communications between the various manufacturing facilities. And yet the same old problem occurs time and again -- the remote plants cannot satisfy the assembly plant's requirements. When the remote plants are asked for their comments, the answer is always the same, "They tell us what they want. We assume that they are right. We begin to buy and to make according to their requirements and priorities -- and then they change them upon us. We have what they don't want, they want what we don't have."

As company management you always have three options; do nothing, do something, or do nothing and make it look like something!

Let us assume that the "do something" option prevails, and that you feel an element of sympathy with the position of the guys at the remote plants. What can you do further? The answer appears simple. Establish a new management policy -- assembly production schedules are to be re-established monthly for the next six months, but the schedule for the next two months is to be frozen; within that two month's time frame nothing changes. We'll make what we said we would make.

Now things begin to get really wild. The distributor's complaints are getting worse because they cannot react to the market place. Your own warehouse inventories increase because they now have to hedge against unexpected demand during those two months. Your assembly plant is now second-guessing both the distributors and the warehouses as to what is real demand and what is only destined for "hedge" inventory. Your remote fabrication and sub-assembly plants become outwardly complacent (after all they have a stable schedule). Inwardly however, they are bracing themselves for the inevitable re-direction of management policy once the euphoric honeymoon is over; once everbody recognizes that the company which once had an indisputable reputation for service has now become inflexible and un-reactive to the market place it serves.

Back to the management drawing board! The next step? Who knows? Let us hope however that at least some consideration is given to the potential advantages of "distribution" -- a Distributed Processing environment, using Distributed Systems under the overall auspices of Distributed Management Control.

The definition of this last term - Distributed Management Control - is the crux of the whole matter. If implemented correctly it becomes the backdrop for all management control mechanisms and therefore for all related systems work, particularly in the area of Manufacturing Control.

As an example let's look at the interface between the main plant and the remote plants in the earlier example. In the context of management control it went through three distinct stages:

Stage 1: Very informal, lacking in commitment from either side, unpredictable. Each manager knowing what he is being held responsible for (and pleasing the assembly plant is not necessarily it!)

Stage 2: Very straight forward, anything the assembly plant wants immediately becomes a mandatory requirement upon the remote plant whether it's feasible or not. Each remote plant becomes a "puppet", accountable for what it cannot control.

Stage 3: Very structured, "you can only have what you thought you wanted 2 months ago"; total accountability.

How would it look with Distributed Management Control? In the simplest terms it would be like a mature customer/vendor relationship; formal when required, but flexible wherever possible. More specifically it would be like a high-volume customer/vendor relationship -- the sort typically controlled by a formal blanket purchase order with a series of releases against it.

The most important characteristic of such a relationship is that it can be monitored. The "bounds of reasonableness" are established so that both "sides" can see an exception as it occurs and examine its desirability prior to its becoming critical. Each has the "right" to refuse or accept an exceptional situation (as defined by their "blanket" agreement) making each accountable for his own performance. Equally, each recognizes the desirability of avoiding such exceptional circumstances and (hopefully) sees improved information and communication as the means by which this may be achieved.

Enter the world of Distributed Sustems. To quote from the APICS (American Production and Inventory Control Society) Dictionary, the term Distributed Systems "refers to computer systems in multiple locations throughout an organization, working in a co-operative fashion, with the system at each location primarily serving the needs of that location but also able to receive and supply information from other systems within the network."

In terms of the earlier discussion on Distributed Management Control, I would like to concentrate on the implied stand-alone characteristics of such systems in such a network. Obviously inter-communication is important and each system has to recognize the level of its dependence upon outside sources. However, the whole essence of Management Control such as we have discussed in this paper is its ability to operate in spite of everybody else. Whereas the system should be capable of communication with others, it should not be dependent upon it.

And this leads right into the second half of this paper -- how do today's on-line inter-active systems relate to such a management environment.

I would like first to dispense with a semantics problem - "Closed Loop Systems". It seems likely that this term is to win the buzz-word title of all time - more people appear to have listened, for longer, to more other people giving more different definitions of this one term than any other since Materials management became a science rather than a fall guy!

I hope you will bear with my own version of it.

I see it as being comprised of three functions - evaluation, feedback, and commitment. As such it represents a significant step forward in materials management practice. (after all it is not long since the only available words were plan, expedite, and smoke screen!).

What of these three more contemporary words:

Evaluation: Gone are the days (I hope) when the feasibility of a given production plan was merely a coincidental characteristic of it! Company managements have become increasingly more interested in Manufacturing's view of their proposed sales (shipment) schedules and, as such, are expecting more refined and provable answers. Meanwhile manufacturing now recognizes that the only way to avoid being "dumped on" is by quickly identifying problem areas - production bottlenecks, inventory restrictions, etc.

Feedback: This is the second "third" of a closed loop system - equally important but far less common that "evaluation". It is amazing how many companies that, having identified a production problem, limit their reaction to one of "gritting teeth"! Why? For at least two system-related reasons; the first being that their systems were designed only to identify the effect of the problem not the cause, and the second being that even if the cause <u>was</u> identified the production schedule cannot be juggled within the computer system to correctly reflect what manufacturing will eventually do to avoid it. Classic cases, always resulting in negligible feed-back.

Commitment: This third constituent of a Closed Loop environment is always the most difficult to obtain. However without it, the other two are useless. It is the difference between driving a manufacturing facility from a "statement of desire", and driving it from an agreed and feasible schedule. If a vendor cannot deliver on time, change the purchase order date so that the system can re-evaluate the impact. If we cannot ship to a customer on time, again, change the date on the order. Change anything that conflicts with reality. Drive the system off what we think we can do, not what we would have liked to have happened if everything had gone right. If a discrepancy occurs, evaluate it, feed it back to the point at which it can be averted, and commit to it. Buffer manufacturing against desirable schedules, give them something they can do, something they can commit to.

That's called closing the loop". As can be seen from the system descriptions that follow, the basic "closed loop" philosophies have done much to influence the design of today's state-of-the-art manufacturing systems.

What are the "components" of such a manufacturing system? (see Figure 1)

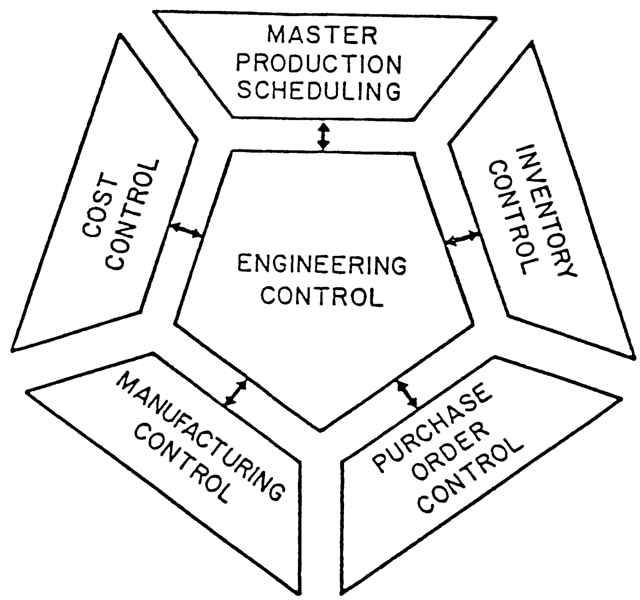

Figure 1 - Components of a Manufacturing System.

<u>Engineering Control</u>: This system should perform all maintenance and reporting functions concerning the system's six prime data bases:

-Item Master: One record for every part number relevent to the plant in question. It should contain all descriptive and policy information related to that part.

-Product Structure: A series of records for each manufactured item describing the lower-level items (raw material, purchased components, etc.) from which this item is made.

-Routing: A series of records for each manufactured item describing operation-by-operation how this item is to be made on the shop floor.

-Process: Descriptive information about each "process" identified on the routing data base, together with a list of tools required to complete that "process".

-Tool: One record for each tool referred to in the Process data base. It should contain descriptive and policy data related to the use and maintenance of that tool.

-Work Center: One record per production "center" in the shop. It should contain scheduling and efficiency data, capacity details, and cost rates.

Master Production Scheduling: This system should embody three functions - Production Planning, Resource requirements Planning, and Master Production Scheduling function itself. Specifically:

- Production Planning: The development of an overall statement of production and its "explosion" to the more detailed master scheduling level.

- Resource Requirements Planning: A broad-brush review of the likely impacts of a given master schedule upon critical production resources.

- Master production scheduling: The development of a realistic and detailed Master Schedule based both upon the exploded Production Plan and upon evaluation of Resource Requirements.

Inventory Control: This is the system that should translate the master schedule into a detailed replenishment plan and monitor progress and activity levels against it. Specifically:

- Planning: The development of the replenishment plan both for purchased and for manufactured items.

- Releasing: The preparation of a

replenishment order for release -- either for its placement with a vendor or for its dispatch to the shop floor for picking and manufacture.

-Expediting: The monitoring of the overall status of purchase and manufacturing orders.

-Recording: The recording of activity against each purchased or manufactured part -- issues, receipts, shipments, scrap, etc.

-Accounting: The development of all associated accounting transactions and the analysis of these and their resulting inventory levels.

-Management: The summarization of activities and performance of the planning-releasing-expediting -recording functions and their presentation in a form which management can interpret and act upon.

Manufacturing Control: (or more precisely, Shop Floor

Control) the further translation of the manufacturing replenishment plan (as developed in inventory control) into a detailed operation-by-operation statement of work, and the monitoring of status and performance against it. Specifically:

- -Releasing: The identification of the appropriate routing for each production order, and the printing of its shop floor packet.

- -Scheduling: The development of each production order's schedule, and the printing of each order's dispatch lists.

- -Reporting: The gathering and recording of labor and other data from the shop floor.

- -Expediting: The reporting of each order's status and any related exception conditions.

- -Analysis: The periodic review and summarization of shop floor activity and the reporting of overall and detailed performance.

- -Capacity Requirements Planning: The development of a long-term work plan for each work center and the comparison of this with the expected available capacities.

Cost Control: This component of the system should develop the appropriate standard costs used by the accounting function (discussed earlier under Inventory Control) as well as monitor actual purchasing and manufacturing costs against these standards. Specifically:

-Cost Generation: The build-up of tentative and/or current and/or firm standard costs for each part using the system's Product Structure and Routing data bases.

-Standard Costing: The translation of activity against purchase and production orders into their appropriate dollar equivalents, and the reporting both of performance variances and work in process levels.

Purchase Order Control: This system should perform the traditional Purchasing Department functions associated with the placing of purchase orders and the monitoring of vendor performance against them. Specifically:

-Placement: The printing of the

purchase order document itself and where relevent, the individual release schedules for each open blanket order.

-Expedite: The tracking of each order's status and likely "dock" dates

-Analysis: The monitoring of actual vendor performance.

-Reconciliation: The comparison of vendor invoices with their asso- ciated purchase order information.

Now that we have defined these system "components" we can take another look at "closing the loop". Figure 2 shows how some of these individual components tie together, not only from the point of view of logical information flow "downwards", but also from that of feedback (dotted lines) "upwards".

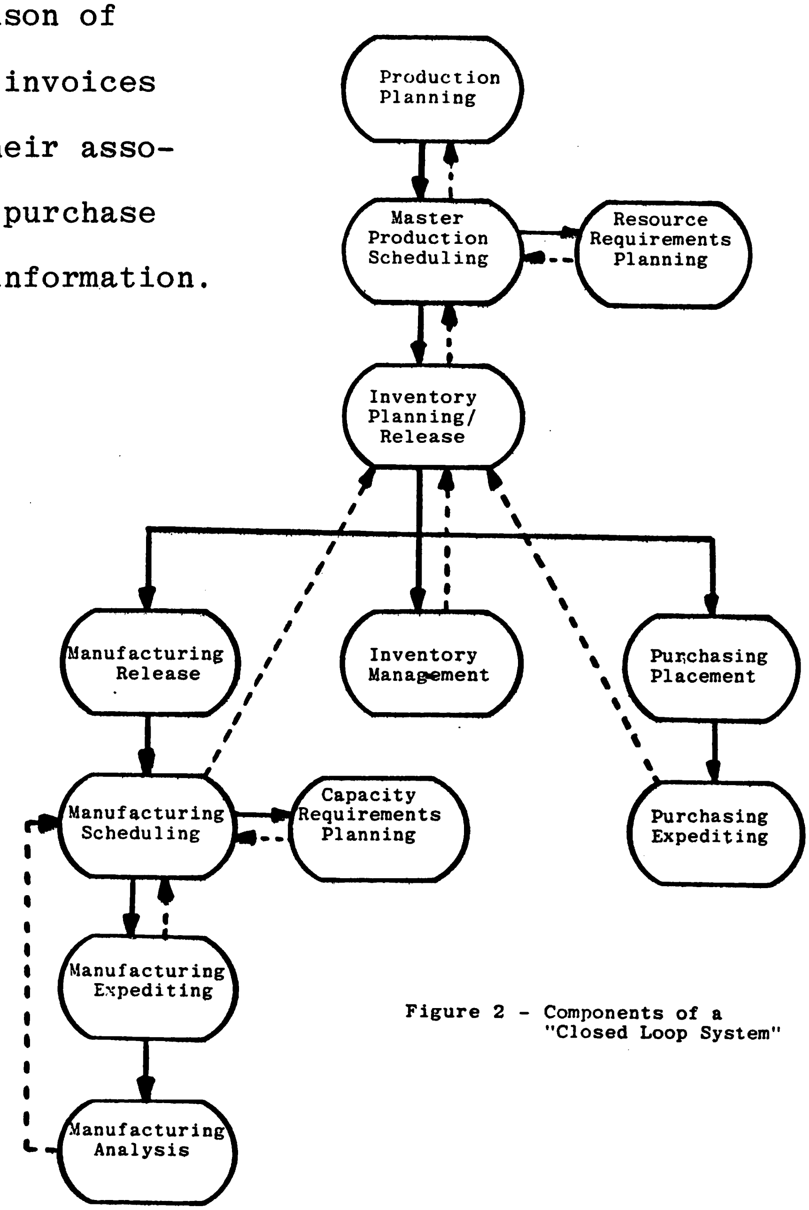

Figure 2 - Components of a "Closed Loop System"

So far we have:

-defined the concepts of Distributed Management Control

-defined a system model suitable for such an environment and shown how it should hang together.

Next we will describe some of the required system features in detail, but once again let us precede the discussion with another go at semantics - this time concerning the term "on line interactive systems:"

The only obvious consistency between the alternative definitions of this term is that none include the words "punched card"! Everything else is up for grabs! For the sake of the remainder of this paper I feel we should standardize on one view - mine, naturally!

Perhaps the best approach is to look at what I see it as not being. In the first case I see it as a blantant exageration of a system's capabilities, and in the second I see it as an understatement (incredible as that may seem!).

First as an exageration; I do not see the term applying to:

-a system with on-line editing but only batch updating capabilities.

-nor to a system limited only to on-line inquiry.

-nor to a combination of the two.

Equally as an understatement; I do not see the term applying to:

-a system that, with one on-line transaction, can evaluate a series of different situations and options, report back (still on line) an optimum result, and, when requested to do so, update a number of file records to reflect that conclusion.

In its simplest terms, therefore, I see the term referring to a system's ability to update files with transactions in full on-line mode and to be able to process an inquiry against those updated files with the immediately succeeding transaction.

What does all this mean to the specification of a good manufacturing control system? A lot. Simply specifying it as "on-line and interactive" is not sufficient. A good system will embody a large spectrum of environments - all the way from pure batch to what I described earlier as an "understatement" (and which I would like to more specifically entitle "interpretively interactive"). Let me give you three examples. One for each of three given environments.

(1) Pure Batch

ABC analysis and reclassification: rarely is a part's ABC classification used to drive any on-line decision-making activities. Its constant update therefore is hardly worth the effort; certainly not worth the overhead associated with on-line recalculation.

(2) <u>On-line/Interactive</u>

Issues and Receipts: in a dynamic manufacturing environment the movement of inventory is a constant activity. Many decisions are made only on the basis of the current availability of the part concerned. Without these movements being "on-line and interactive" the system would be incapable of estimating a part's current availability.

(3) <u>Interperetively Interactive</u>

Production Order Release: as a new order is forced into production to satisfy an urgent requirement the two most critical concerns of an inventory planner are (1) "have I enough inventory of each of the required components?" and (2) "What have I just done to the shop?". Neither are easy questions, and certainly not easy answers. They involve research but it is important enough to know these

> answers, that a system should handle the entire release in interactive mode, and report back interpretively the results. An example of such a result would be the system returning the message, "The release of the total order will cause shortages. However halve the order quantity and we should be OK".

As we go through the description of the system's on-line/ interactive features examples of each processing environment will appear; each, I hope demonstrating that the type of processing used is always a compromise between the need for constantlv uo-to-date data, and the overhead associated with processing in full interactive mode.

ENGINEERING CONTROL (see Figure 3)

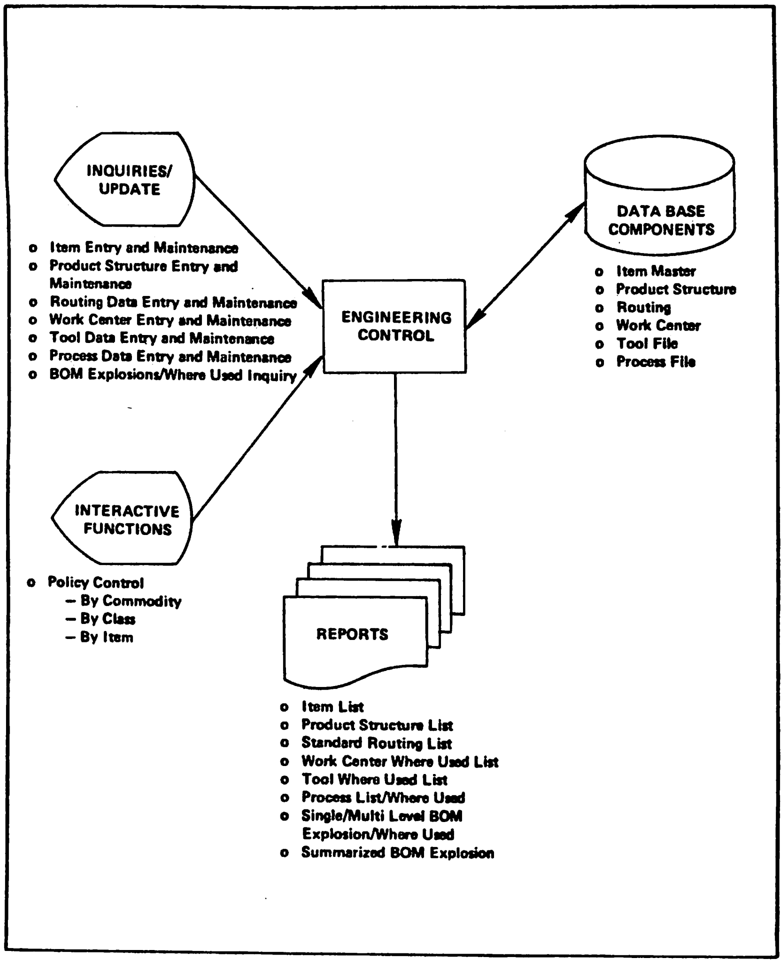

Figure 3 - Engineering Control Overview

This is the system that maintains the six prime data bases listed earlier - Item Master, Product Structure, Routing, Process, Tool and Work Center. Each should be capable of on-line interactive (not necessarily interpretive) update and inquiry. An example is shown in Figure 4 (Screen IM001)

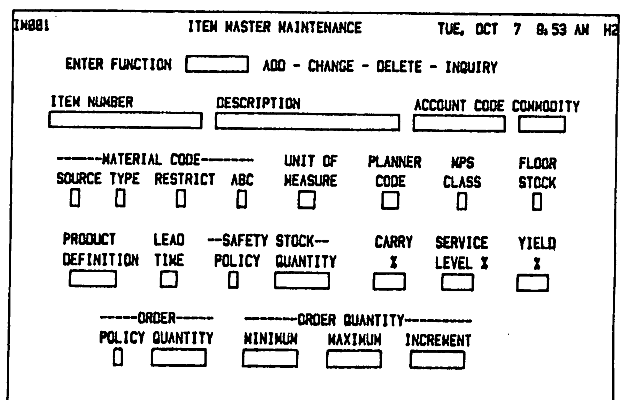

FIGURE 4

This would be the screen through which an Item Master record may be added to the data base (provided it passed some basis validity checks), changed, inquired of, or deleted (provided also that it passed its validity checks).

Altogether there would be seven Item Master screens, some specifically for inquiry purposes only, some for adding or changing other data fields, and some for a combination of the two. However only this screen (IM001) would be used for adding or deleting Item Master records.

Another example of a combination Add-Change-Inquire-Delete screen is shown in Figure 5 (screen PS002). This is used for transactions against the Product Structure and allows specific parent-component links to be updated, etc. The validity checks are more demanding in this case because of the natural structure of the data base. Both Parent and Component Item Numbers must match already existing Item Master records. Otherwise any attempted update will be rejected. The same would be true of the Substitute Item.

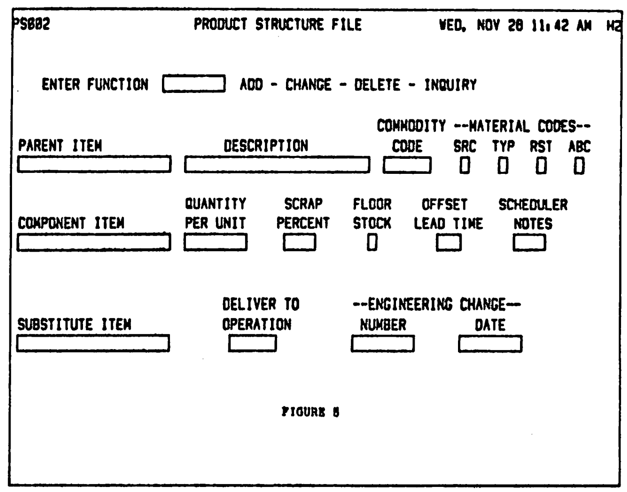

FIGURE 5

Another aspect of interactive processing is also demonstrated by this screen. The six data fields between "Description" and "ABC" are not in fact on the Product Structure data base. They are instead held on the Item Master record for the parent item and are returned by the system for information purposes only at the time of transaction entry.

Two other facets of interactive processing are also applicable to the Product Structure - List-Type inquiries, and "same-as-except" processing. Figure 6 (Screen PS001) shows an example of each. By specifying the Inquiry function and entering a Parent Item Number the system will "return" a list of all associated parent-component link records. It provides therefore the on-line equivalent of a bill-of-material. The second feature here (same-as-except) is an extension of this. Rather than having to specify each parent-component link for a new product structure, an engineer might elect to specify it based upon its similarity with an already existing bill. By using the Inquiry function, the existing bill of material can be listed on the screen. Then having:

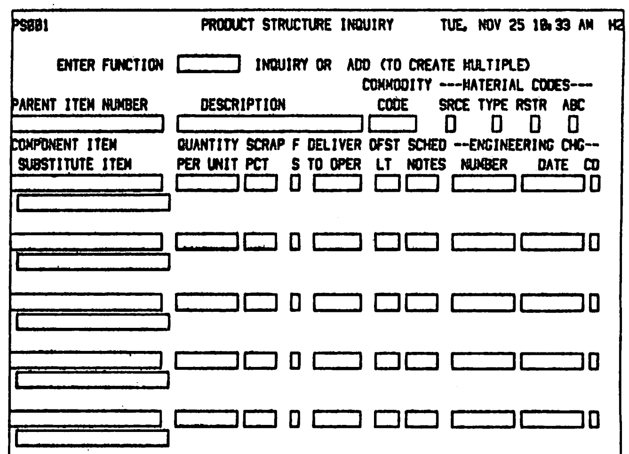

FIGURE 6

-made any adds/changes/deletes to the existing structure to make it specific to the new

-changed the Parent Item Number to reflect the new structure's parent, and

-changed the function from Inquiry to add

The new product structure can be automatically written to the data base.

Figure 7 (screen WH001) shows Where-Used feature. Entering a specific, say, purchased part in the Component Item Number field will cause the system to list all parent links associated with it; or, in other words, all manufactured items that have this component in their single-level bill of material. It is very important for an engineer to have access to this type of information - particularly when designing a replacement for an existing part. It effectively tells him which product structure links he should amend to reflect the replacement.

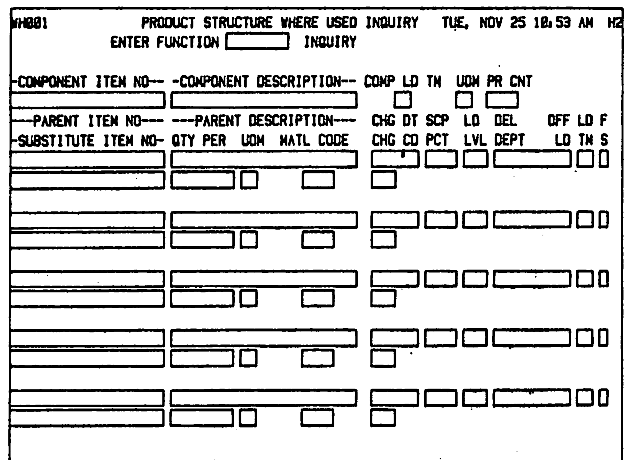

FIGURE 7

The four manufacturing engineering data bases - Routing, Process, Tool and Work Center would also be available for on-line update and inquiry - specifically for add-change-delete inquiry functions.

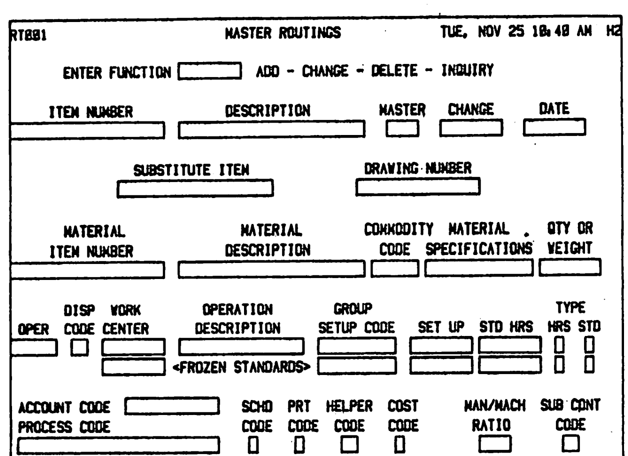

FIGURE 8

Figure 8 (screen RT001) shows the equivalent Routing screen. Once again the system "returns" the heading information. The only updateable information is from the "OPER" (Operation Number) field and on. One point worth noting is the "Frozen Standard" line. This would maintain the standards that existed for this operation at the time that Accounting last "froze" their standards. It would be maintained for as long as required to insure correct reporting of variances.

The operation number shown on this screen assumes a 6-character length. This is to allow the system to maintain both prime and alternate routings on the data base. The first four characters would be a normal sequential operation. The last two indicate the operation's prime/ alternate condition.

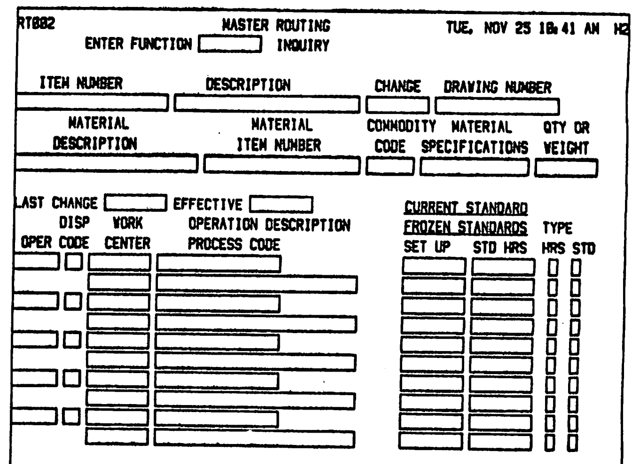

FIGURE 9

Figure 9 (Screen RT002) demonstrates the equivalent list-type inquiry.

At this point it is probably appropriate to discuss the functional inter-relationships between these four data bases. Figure 10 (Manufacturing Engineering Data Base Relationships) depicts this. In each operation record on the routing data base there is reference to a work center (mandatory) and a process (optional).

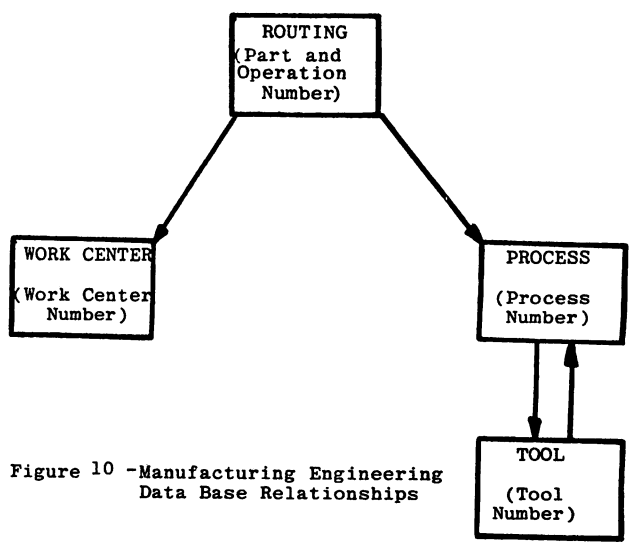

Figure 10 -Manufacturing Engineering Data Base Relationships

These provide the necessary ties-in to these two other data bases. In addition, each process data base record can contain one or more references to the tools required for that process. These references provide the ties-in to the tool data base, as well as providing the necessary where-used references.

Figures 11 through 13 (screens WC001, PM001, and TM001) show some of the data maintained in on-line mode in each of these three additional bases.

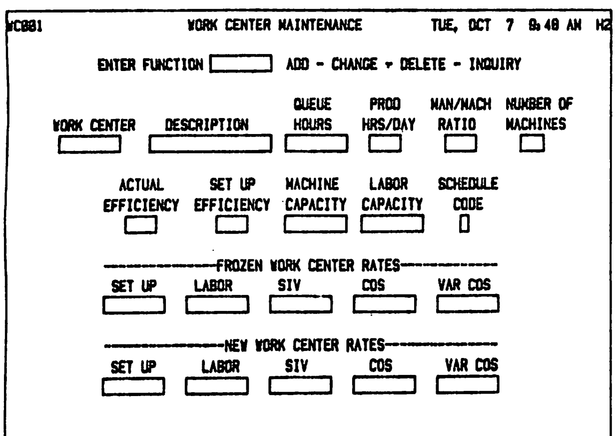

FIGURE 11

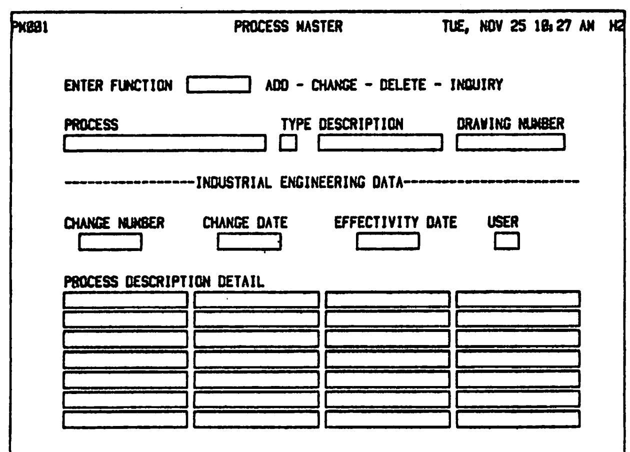

FIGURE 12

One final comment on the Engineering Control System; should any of these six data bases be "distributed"? Or in other words, is it likely that one of the following is true:

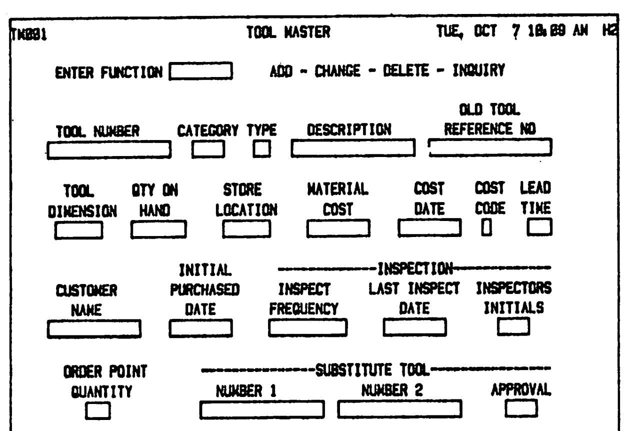

FIGURE 13

-the data originates in one (plant) location and is used by another?

-the data is used by multi (plants) locations?

Typically the only data to which this may be applicable would be:

-the Item Master Description field

-the Product Structure.

If this is so then consideration must be given to the need for inter-location communication of this information. There are really two options to consider:

-frequent copies of this data being made available (in batch mode) to each appropriate location

-remote on-line access to another distributed processor.

Normally the first would be the least complex from a control point of view, but possibly the least desirable as far as a user is concerned.

MASTER PRODUCTION SCHEDULING (See Figure 14)

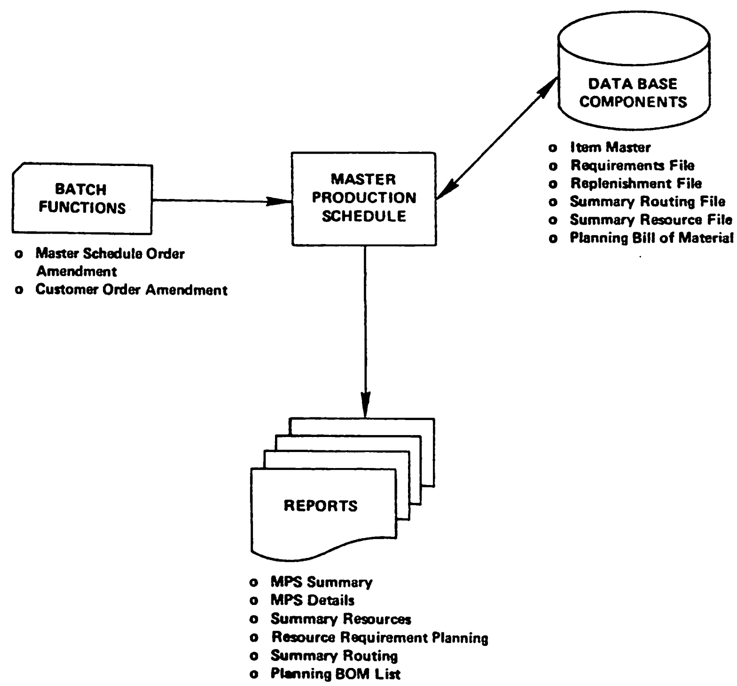

Figure 14 - Master Production Scheduling Overview

As can be seen from the overview this would frequently be viewed as a batch function. This does not mean however that nothing could interact with the Master Schedule in an on-line mode. It is just that neither the development of forecast demands from the Production Plan nor the re-iterative simulation capabilities of Resource Requirements Planning are seen as desirable/practicable on-line interactive functions.

The Master-Schedule-related functions which would be on-line however would be included in the Inventory Control module, just as the same functions would be available for all "inventory" items. These on-line functions are:

-the addition, ammendment or deletion of a production order (or in the case of an MPS item, of the Master Schedule itself).

-the development of lower level component demands as a result of such a change.

-the entry of customer orders against the production schedule

-the ability to inquire the status of a production order (or schedule)

-the ability to time-phase inventory availability, with specific reference to monitoring the "consumption" of a Master Schedule.

The screens required to satisfy these last two items are shown in Figures 15 and 16.

The first (Figure 15) shows Screen RP003. With the entry of the Inquiry function and the appropriate master scheduled item, the system will return a time

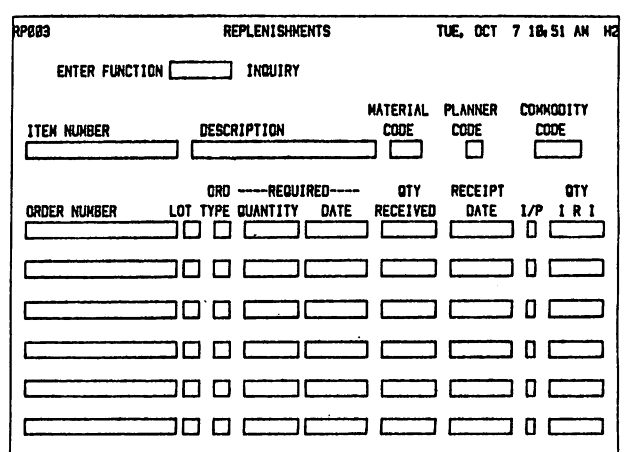

FIGURE 15

phased list of all scheduled production for that item, and the individual status of each production "batch.

Figure 16 shows Screen SD001. The same entry is required (Inquiry plus Item Number) but, additonally, a date range (start/stop) can be specified. This allows the Master Scheduler to concentrate only upon projected activity during the time period under consideration. The first two lines provide details from the part's Item Master data base, one element of which is the part's current balance on hand (if any). This is the starting point of the time-phasing. Each projected activity (either production or usage) is listed in due date sequence and the effect of such activity shown under the heading AVAIL (available).

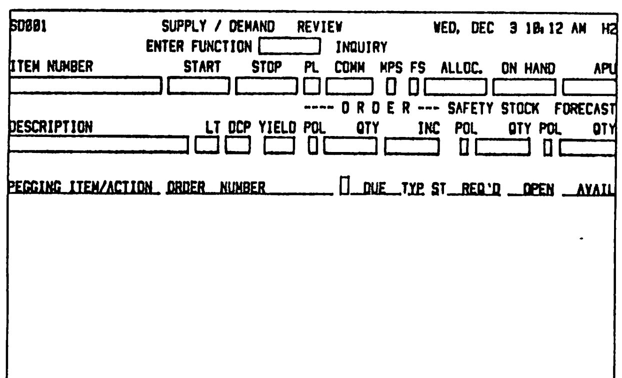

FIGURE 16

INVENTORY CONTROL (see Figure 17)

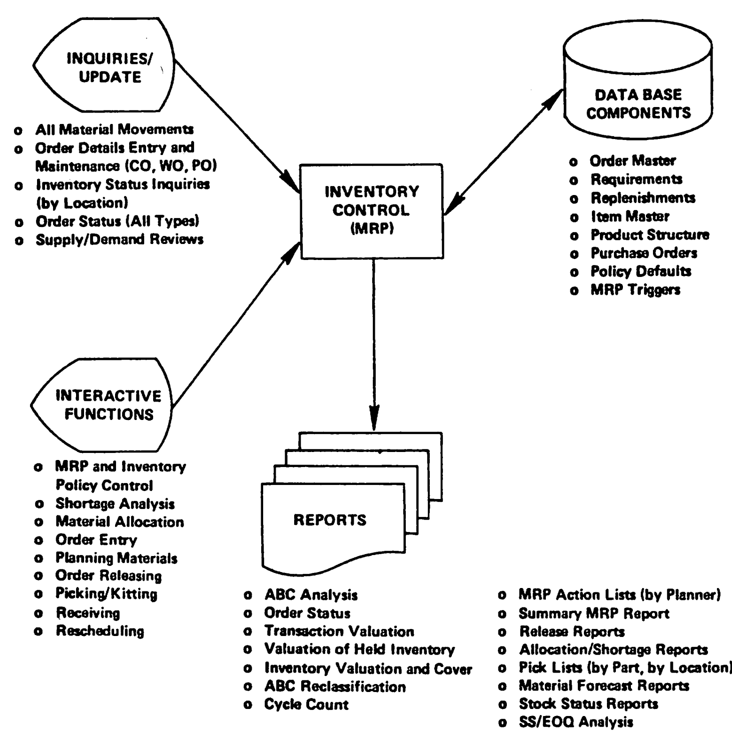

Figure 17 - Inventory Control Overview

As can be seen from the overview this part of the system is highly interactive in nature. Let us review some of these functions under the same headings as we used earlier-planning, releasing, expediting, recording, accounting and management.

(1) Planning: The ability of the system to develop replenishment plans (both purchasing and production) for each recognized inventory item is the nucleus of the whole system's operation. The

technique used - MRP - is a method of developing a time-phased picture of each item's expected usage and suggesting the appropriate replenishment plan to avoid potential stock outs. This type of review is conducted in a logical sequence dictated by each part's position in the product structure. The highest level items are tackled first so that their replenishment plans can be translated into projected component demands prior to that level itself being reviewed by MRP. In the simplest terms the system recognizes two record types - supplies and demands. Each of these are split again:

-supplies: Production orders
Purchase orders

-demands: customer orders
forecast orders

dependent demands

The latter two are typically created automatically by the system - forecast orders from a forecasting algorithm , dependent demands from the explosion of production orders created at the next higher level in the product structure. The other three would be input to the system in on-line mode:

Production orders:	through screen OP001 (see Figure 18)
Purchase orders:	through screens P0001 and P0003 (see later purchasing discussion)
Customer orders:	through screens OP001 and OM001 (See Figures 18 and 19)

Two points are worth noting regarding the OP001 screen. Firstly that the order type field dictates whether the order being entered is a production or a customer order - or a combination of both. This feature allows for special customer orders to be entered that are for non-inventory items. They do not have to match a record on the Item Master; they are planned for shipment directly from work in process.

The second point relates to the field "Standard

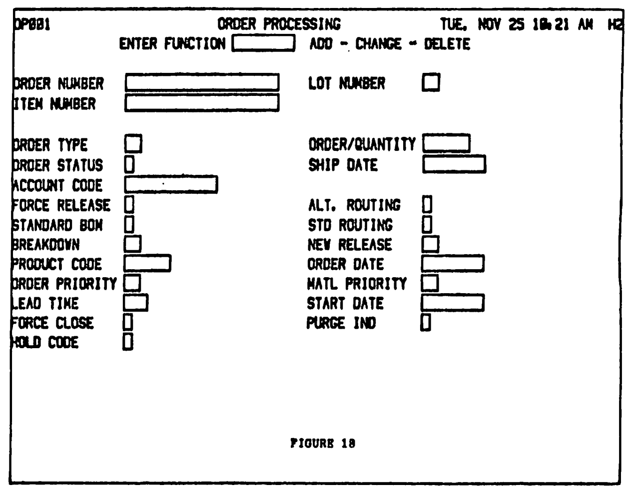

FIGURE 18

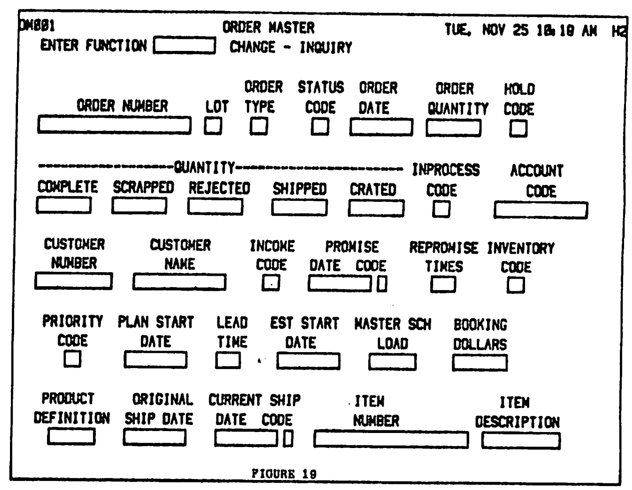

FIGURE 19

BOM". The entry of an "N" (No) here (whether for a special customer order or for a non-standard production order) allows the system, using another Order Processing screen to present the same-as-except option to the inventory planner. Using this feature, a planner can either override the system-suggested bill-of-material, or simply substitute a part, or change a "Quantity per".

(2) Releasing: One of the system's most powerful "interpretively interactive" functions would be covered by screen OP004 (See Figure 20). This would allow a user to:

-check for potential shortages prior to the release of an order

-force-allocate inventory to an order

-force-de-allocate inventory from an order

-force-release an order.

The Shortage function amply shows this ability. With the single entry of an Order Number (typically for an existing production order) the system:

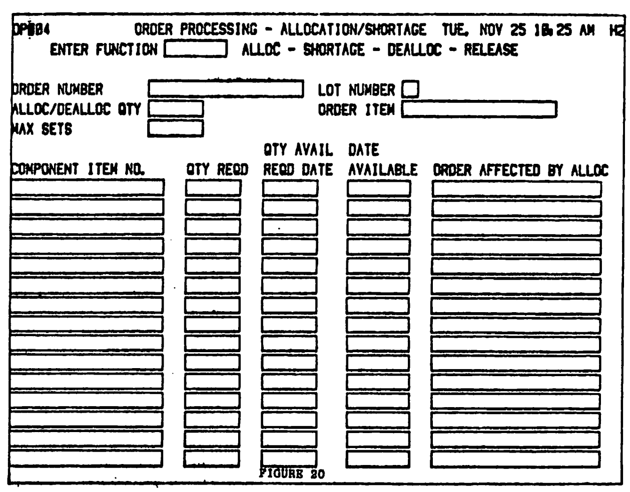

FIGURE 20

-ascertains the component items that need to be available.

-checks for any potential shortage condition that may exist on these items.

-displays on the screen these potential shortages.

-ascertains the date on which these shortages should go away if all goes according to plan.

-calculates the maximum partial quantity (if any) that this order could be released for while still avoiding the shortage.

(3) Expediting: the system would provide total on-line reference capability for existing production, purchase and customer orders (see Figures 21 and 22 - screens RP002 and RQ002).

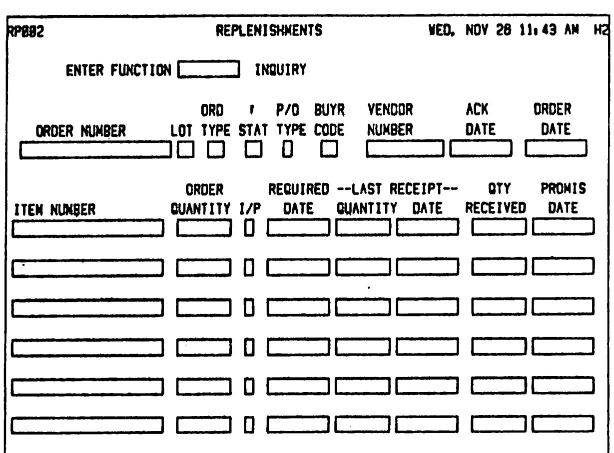

FIGURE 21

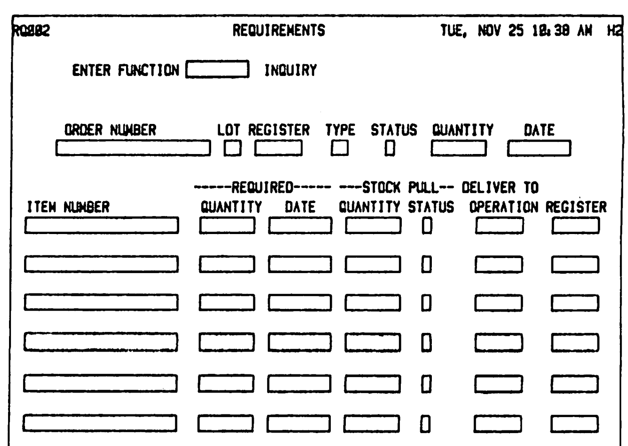

FIGURE 22

The first shows the status of the order itself, the second shows the status of the components.

(4) <u>Recording</u>: All receipts and issues, would be on-line transactions as would the inquiry on an item's balance on hand and its one or more stocking locations. The three screens (MV001, MV002, and IM005) are shown in Figures 23 through 25. A number of points are worth noting regarding the two movement

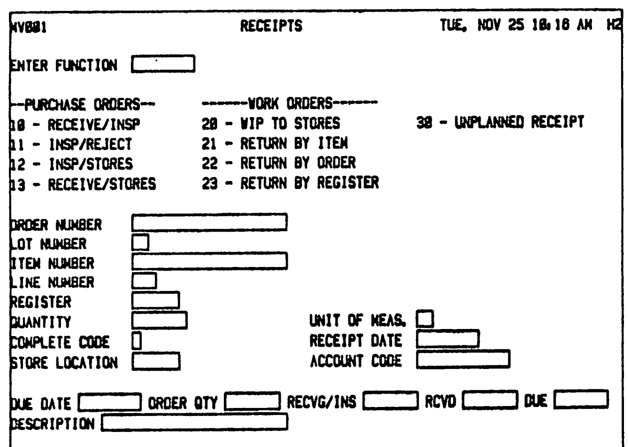

FIGURE 23

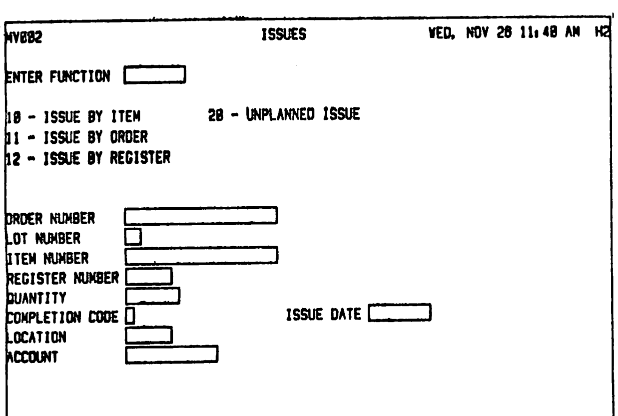

FIGURE 24

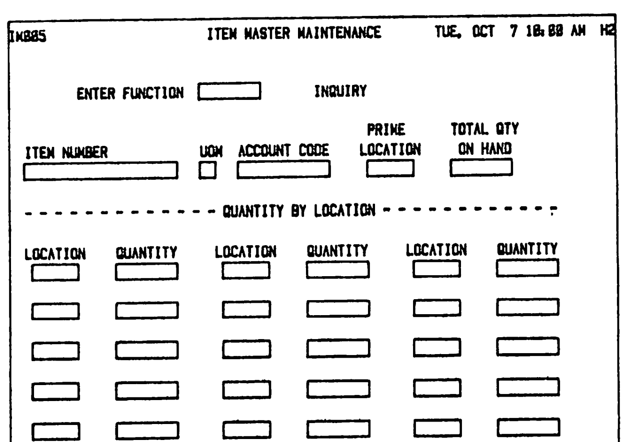

FIGURE 25

screens.

-unless a transaction is catagorically stated as unplanned (functions 20 and 30) it will always be validated against an existing supply or demand record. If one cannot be found, or there is some other discrepancy, the transaction is rejected

-a completion code can be set if the transaction is to close-short the supply or demand record.

-if a store location is not specified it will assume the part's prime location.

-the issue transaction can be "interpretively interactive". Functions 11 and 12 will automatically create issue transactions by "implication".

-receipts against a purchase order can be two-staged - firstly into inspection, then into stores.

(5) Accounting: Each Item Master record contains an account code. A debit or credit transaction is created (at full frozen standard costs) wherever a receipt or issue (respectively) is processed.

The contra-entry is also created based upon the transaction's own account code. This may be specified in the transaction itself (for instance, for a scrap transaction) or in the original order record against which it is being processed. The system also keeps track of the inventory value and analyzes this by product line, commodity code, etc.

(6) Management: One of the most powerful features in an inventory control system is the ability to drive the inventory management policies from "default" records. This enables the inventory planner, (as can be seen from figure 26) to specify his safety stock, order quantities etc at a "generic" level (possibly commodity code) and with one small change, radically affect the individual replenishment plans being developed for each item within that commodity code. The end effect obviously is to impact the projected inventory levels by reflecting changes in management policy.

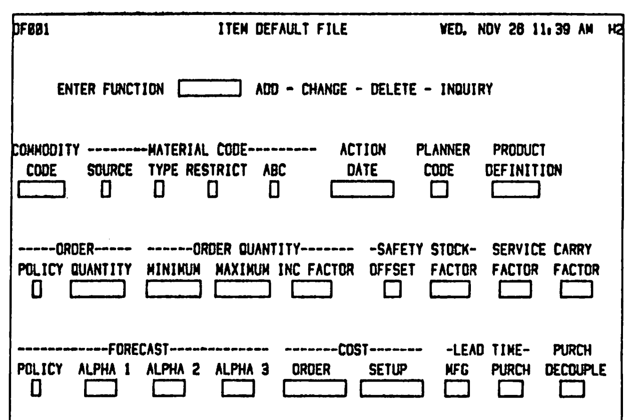

FIGURE 26

MANUFACTURING CONTROL (See Figure 27)

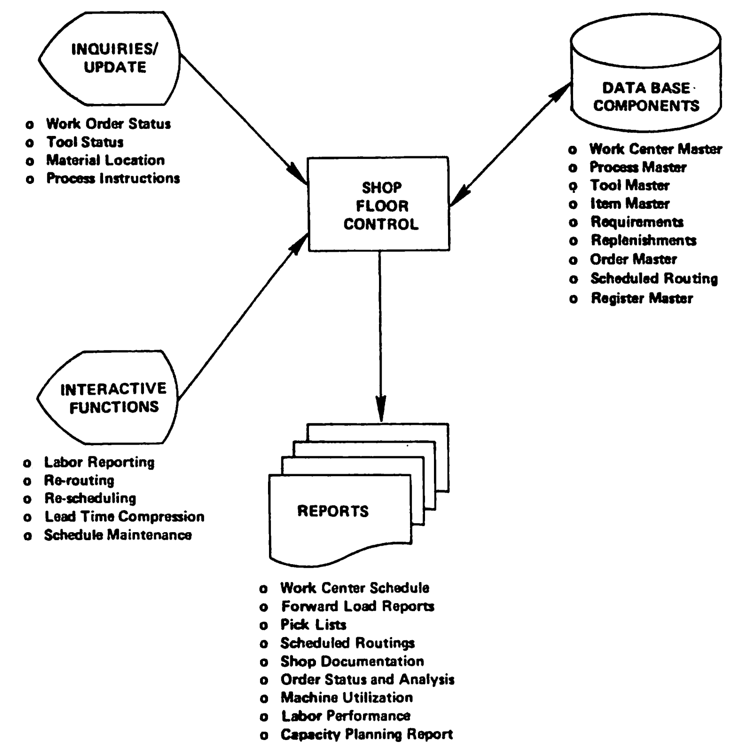

Figure 27 Manufacturing Control Overview

Four of the earlier-listed functions of the Manufacturing Control system should be on-line and/or interactive. They are: Order Release, Order Scheduling, Shop Floor Reporting and Order Expediting (or Status Reporting). The other two, Analysis and Capacity Requirements Planning, would normally be pure batch.

In interactive mode an order's release and the development of its operation-by-operation schedule should be simultaneous. This would be instigated by the OP001 screen described earlier --

specifically by the Force Release indicator. The end effect would be a completely-developed back schedule of all work based upon

-the order's due-for-complete date

-the order's size

-the routing used

-the projected move and queue times betweens operations

It should be available for on-line Inquiry - see Figure 28, screen SR001.

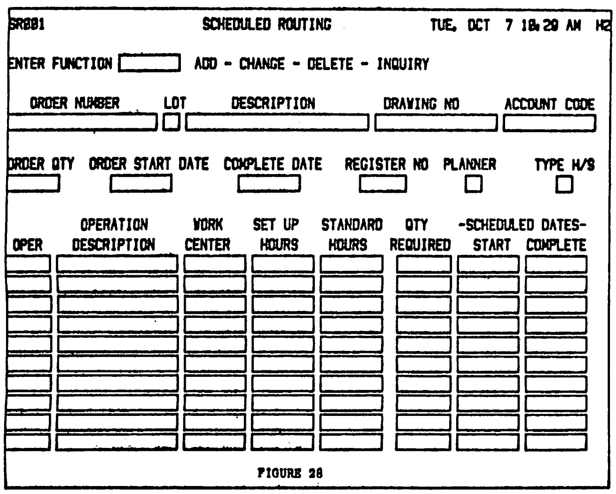

FIGURE 28

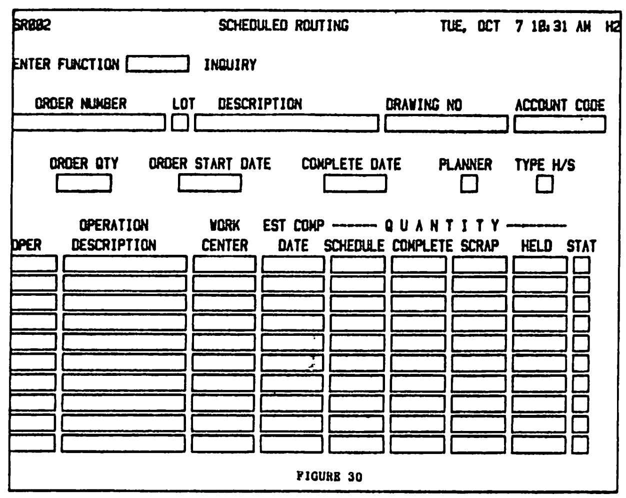

FIGURE 30

As labor transactions are posted - see Figure 29, screen SR007- each operations status should be maintained and available for on-line inquiry see Figure 30, screen SR002.

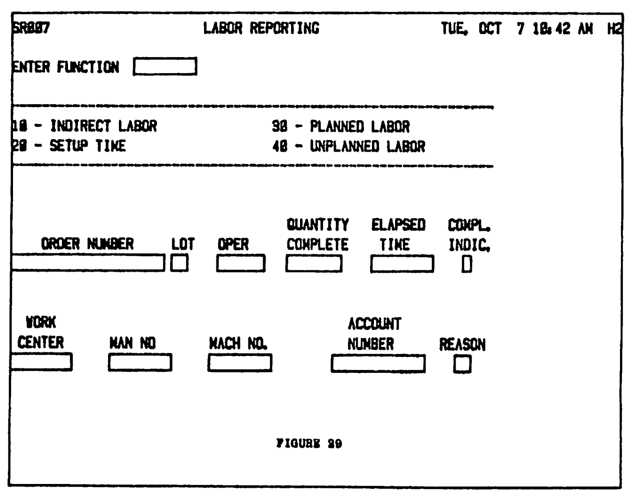

FIGURE 29

COST CONTROL (See Figures 31 and 32)

Standard Cost Generation

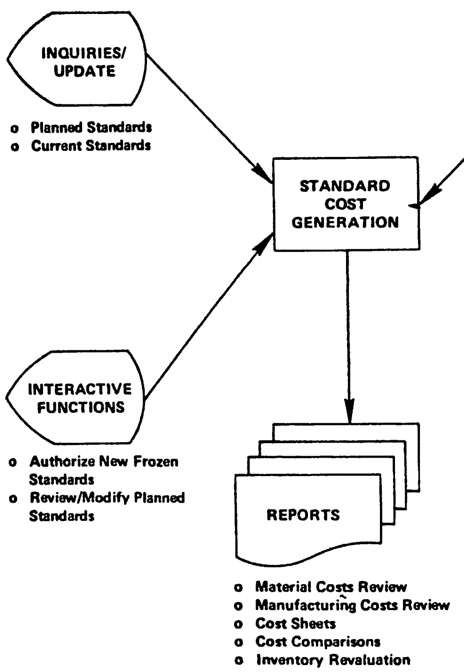

Figure 31 - Cost Control Overview (1)

Standard Costing

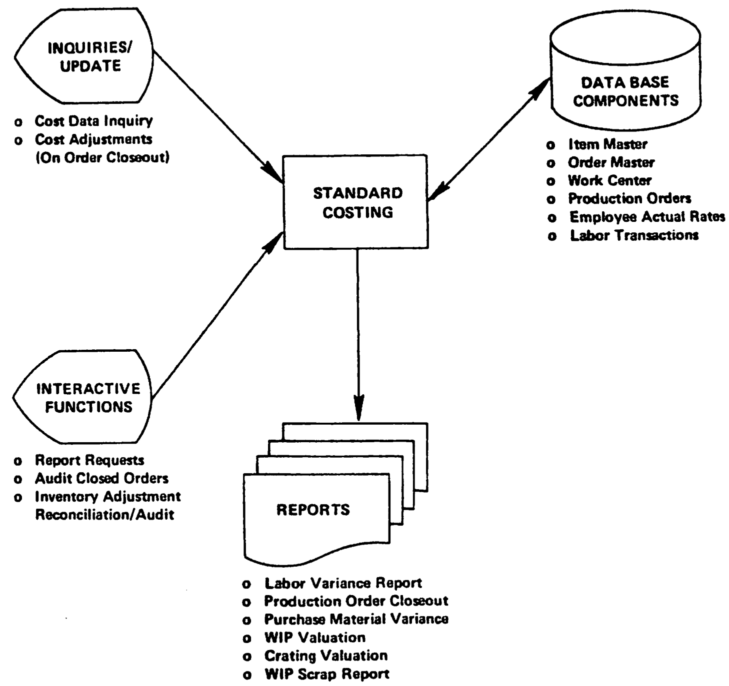

Figure 32 - Cost Control Overview (2)

The two overviews describe most of the required system features. Only one screen relates to the cost generation function and that is shown in Figure 33 (Screen IM003). The Change function allows the interactive update of the New and Current costs; it does not allow for that of Frozen. These have either to be

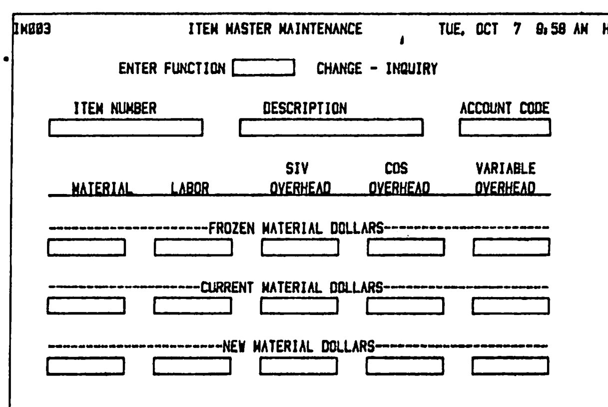

FIGURE 33

"rolled" from the Current or New costs, or to be amended in batch mode. Three screens relate to the Standard Costing function; each being an inquiry about an order's costs to date. they are "hierarchical" in design - one provides costs for the order as a whole, another a summary of costs by operation, and the third the back-up detail of an individual operation's costs. The second such screen (SR004) is shown as an example in Figure 34.

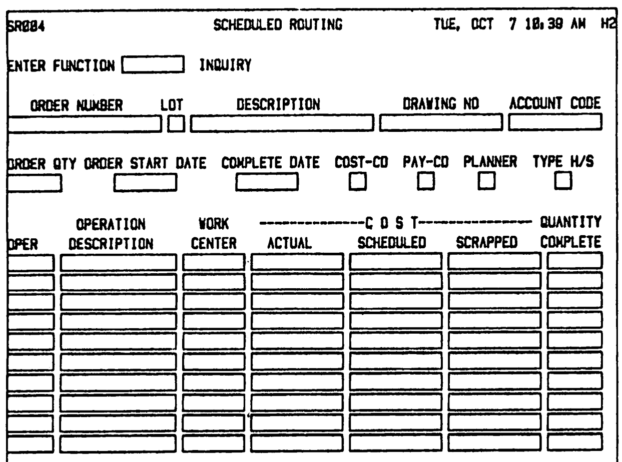

FIGURE 34

PURCHASE ORDER CONTROL (See Figure 35)

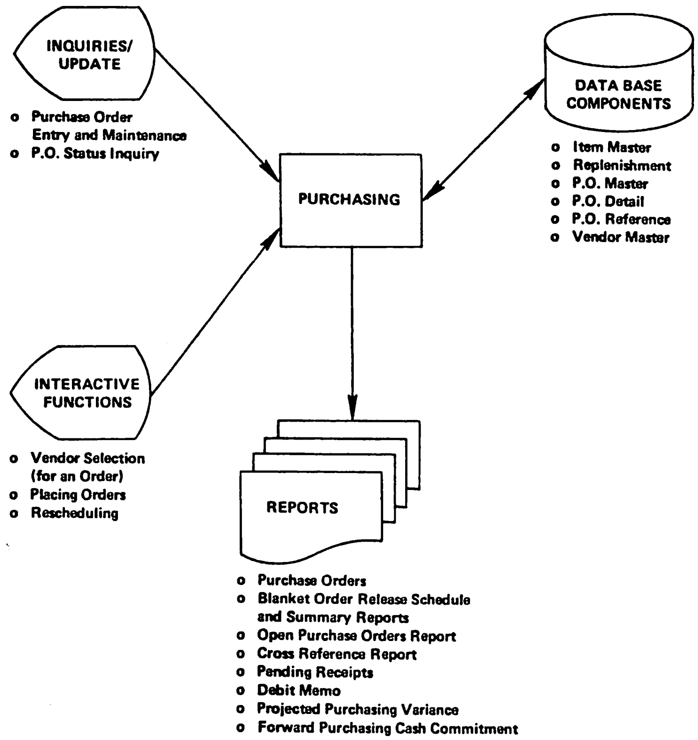

Figure 35 - Purchasing Systems Overview

As was stated earlier this system component would provide help for the purchasing department in their placing and expediting of purchase orders. In all other respects -- purchase order printing, invoice reconciliation, vendor analysis, etc- the system would perform in batch mode. Figures 36 through 38 show the screens that would be used

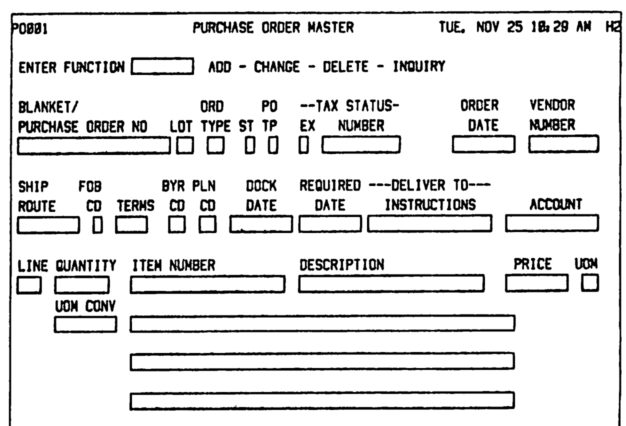

FIGURE 36

to iniate an order (screens P0001 and P0003) and to inquire as to its current status (P0002 and again P0003).

The system should allow for purchase orders to be placed both for discoete quanties and as a series of blanket order releases.

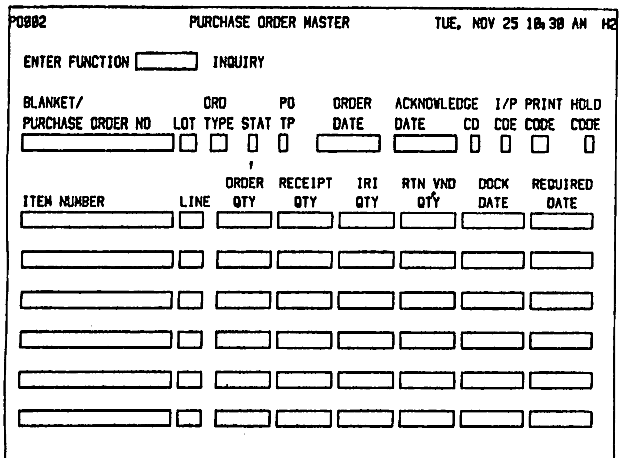

FIGURE 37

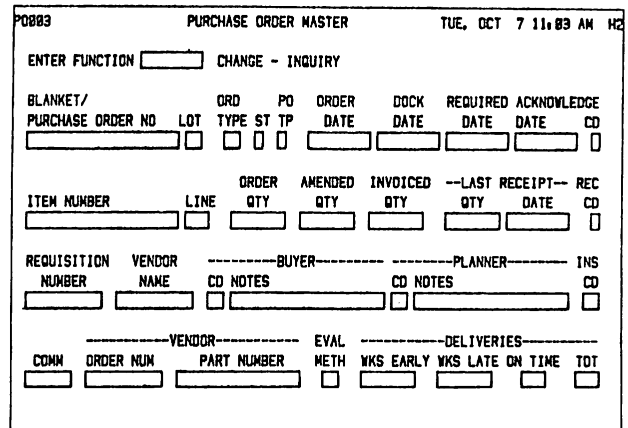

FIGURE 38

SUMMARY

So that's it; an on-line interactive system capable of handling a distributed environment. Obviously it has to be far more capable than just this brief overview can depict. However, much of the remainder of the system would almost follow by implication from the nucleus discussed here.

Let us finally return to the more conceptual requirements that we reviewed earlier and hopefully agreed.

(1) everything hangs upon management's ability to implement new techniques of management control.

(2) the new "techniques" are nothing more than a logical extension of some very basic management practices. The difference is that these have to be formalized in order that they may be "distributed" and implemented.

(3) in a distributed environment the majority of control problems arise in the interfaces not in the manufacturing plants themselves.

(4) a good system will not only be dependent upon but also positively encourage, Evaluation, Feedback and Commitment.

(5) as representatives of a service organization within our own company it is <u>our</u> responsibility to help our management understand these aspects of a distributed environment.

NOTE

The screen formats reproduced in this paper represent a selection of those available in Martin Marietta Data System's MAS-H application system. For further information concerning this system please contact:

Richard M. Nemesson
Director of Marketing
Martin Marietta Data Systems
6301 Ivy Lane
Suite 300
Greenbelt, Md. 20770