EXPERIENCES WITH THE

MANUFACTURING PACKAGE MFG/3000

By

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I. Introduction

MFG/3000 is a collection of three software modules that form an integrated MRP-based manufacturing support package. It is oriented to manufacturers who manufacture and assemble discrete parts, where a primary goal is to minimize inventory investment, yet maintain adequate and timely supplies for production and customer orders. On-line use is encouraged through the use of highly simple menu and data entry screens on CRT terminals, although batch input is available.

MFG/3000 is structured on IMAGE/3000 data bases, and permits the use of QUERY for ad hoc and customized reports, as well as some emergency data base "fixing." The on-line programs utilize DEL/3000, thus requiring HP 264X terminals.

The relation between the three software modules is shown in Figure 1. Engineering Data Control (EDC) maintains descriptive, cost, and planning information about all parts, and bill-of-material workcenter, and routing information about the manufacturing operation. In addition, engineering change information regarding future changes in a bill-of-material and miscellaneous remarks about a part or bill-of-material may be stored. The Inventory and Order Status (IOS) module maintains records of planned and actual inventory issues and receipts. Work and purchase orders are entered directly into the system. Upon request, IOS traces through the relevant bills to determine and allocate all needed parts for a

work order (which can refer to only one fabricated part). At this time the user can determine if all needed parts are or will be available. At the proper time, based on specified lead times, pick lists are generated. The input resulting from the actual pick operation creates a reduction in inventory level and a stock activity record. Likewise, receipts create a historical stock activity record. Such records can be accessed on-line and are purged on a periodic basis.

Finally, the Material Requirements Planning (MRP) module is a planning tool to help management balance current and anticipated demand for a part with current and anticipated supply for the same part.

HP recommends that there be at least two management positions associated with the implementation and operation of MFG/3000. The User Trainer is responsible for educating users as to the proper procedures for using the system, including on-line transactions, management policies, and use of printed reports. The System Administrator is responsible for the proper operation of MFG/3000 itself, including data base integrity and security, maintenance, back-up, and modifications as required.

This paper will discuss the experiences of one of the earliest users of MFG/3000, first from a user point of view (Section III), and then from a System Administrator view point (Section IV). Perceptions gained during implementation of an order processing system are shared in Section V. Enhancements, potential and recommended, are discussed in Section VI.

II. System Installation

Vetter Corporation is a manufacturer of motorcycle accessories and employs approximately 250 people at an Illinois facility and approximately 125 at a west coast California plant. It has experienced a high growth rate over the last few years and has had a continuing problem relative to materials required for the production and support of its products. In order to solve these problems, a program of investigating computer systems for inventory management was begun during the summer of 1977.

In the fall of that year, Systems Design Associates (SDA), a computer consulting firm, was engaged to perform a market survey and analysis and to make recommendations regarding feasible computer systems. Among the criteria for the system were:

1. Reasonably powerful data base management system software
2. On-line query capability into the data base
3. Ability to handle multiple data bases
4. Ability to handle up to 24 on-line CRT terminals simultaneously, with at least three background batch streams
5. Availability of adequate maintenance and vendor support
6. Availability of a reasonably powerful MRP application package
7. Capacity for future expansion

Primarily because of the on-line data base query capability, there were few feasible systems to consider.

The HP 3000 and MFG/3000 were studied during the first months of 1978, followed by a purchase of an HP 3000 Series II Model 6 on March 22. Besides MFG/3000, this system included 320K of main

memory, two 50 MB discs, a 600 LPM line printer, a 1600bpi tape drive, the MPE-II operating system, the IMAGE data base system, QUERY, DEL for terminal management, and COBOL. The 3000 arrived on May 2 and was installed on May 10. The industry specialist from the Los Angeles office installed the EDC package on May 12, and the following week on May 19, he installed the IOS package. On June 9, the MRP package was installed. The system has been in continuous operation since that date. During the fall of 1978 an upgrade was made to a Series III with one megabyte of main memory and a 120 MB disc was ordered. In addition, the new operating system MPE-III was installed in September, 1978. A 9600 baud lease line connects the Illinois plant with the California computer facility.

After system selection, SDA was contracted to perform facilities management and MFG/3000 administration during installation and until system operation stabilized and Vetter personnel could be properly trained. Turnover of system management was completed during the latter part of summer, 1978. Currently, SDA is designing and supervising the implementation of a comprehensive Order Processing System—including order entry, accounts receivable, warranty picking, shipping, and inventory allocation—which is discussed in Section V.

III. MFG/3000 From A User Point of View

The EDC package is somewhat of a misnomer for production description. It could be more accurately described as a definition module, and more specifically, the definitions are all defined in

terms of manufacturing or production criteria. It is broken down into three primary divisions:

1. Part definition—Data elements directly tied to a part number. Structure definition, which is the relationship between a number of parts which describe a finished product or sub-component.

2. Planning and control function for purchased parts as well as fabricated goods.

3. Routing and work center section to describe work centers and activities which occur at the work centers to produce finished goods and sub-assemblies.

The IOS package handles inventory, including stock locations, quantities on hand, and other essential elements necessary to track and maintain accurate inventory records. The second portion of this relates to orders—purchase orders and their associated vendor information, and work orders, which are essentially in-house purchase orders and associated pick lists and materials requisitions to drive the work order system.

The MRP package is very complete, allowing multi-purpose policies and scheduling techniques. It is a re-generative type in that it is a batch type program which is run once a week in our plant. It is essentially driven by the IOS and EDC packages; and if those two have been brought up in a complete manner, the MRP package simply strips data from both and produces a series of reports which control and schedule both in-house work orders and out-of-house purchases.

Implementation from the standpoint of the users is reasonably defined by the structure of the system. The EDC package must be

brought up first and item data entered so that it may be transferred in a batch job to IOS in order to allow the warehousing people to begin to work on their inventory counts. We have found that at our site, with the item data set complete and outstanding purchase orders entered on the IOS data base, the warehousing functions can begin by receiving the outstanding purchase orders and by commencing cycle counts which are provided by the system. This will allow purchasing people to begin to become familiar with entering purchase orders on the system which have been initiated by their old manual inventory control system.

Essentially, this allows a small step toward bringing them out of their old system into an automated one and reduces the trauma of grossly exposing them to all its facets at the same time. The warehousing people at this point are simply exposed to receiving goods on the computer and cycle counts. At this point, two parallel lines develop—the warehousing group can do physical inventory and load the counts on the computer and verify the inventory by additional cycle counts to guarantee the accuracy of their data, and the person responsible for developing the EDC structure information can now begin to load the structure data required to define the assemblies and sub-assemblies required in the plant operation. This data is necessary prior to the development of any internal work order situations. At this point, the purchasing people have been exposed to the system and are loading their purchase orders. The receiving department is receiving goods acquired from those purchase orders. Incoming inspection of those goods may be implemented at any point in this cycle, depending on the

local needs. At the same time, the warehousing people are becoming familiar with the cycle counts and details of the system necessary to maintain their inventories.

The final step in the process is—with the structure information loaded—a final review is required of the EDC information necessary to define inventory control and purchase part definition. This information relates to lot sizes, lead times, and policies, etc. It is extremely important that they be related to the real situations in this plant and that they be applied with good inventory management goals in mind and good purchase policies. This is important because of the fact that the MRP program uses this item data in calculating inventory purchases and demand. The system simply emulates the buying decisions and the manufacturing decisions which have been attached to their component part. In essence, poor purchasing information will be followed by the computer and implemented just as effectively by the computer as it would by an individual.

If the EDC control portion has been implemented properly and with all due regard for economy and control and the IOS portion implemented with accurate inventories and outstanding purchase orders, the final step is to load a master schedule useable by MRP to create the materials requirement plan for the plant. The key in developing a master schedule is, of course, to weigh the needs of the sales forecast with the inventory and cash goals provided by a finance group to provide a realistic schedule within the capabilities of the physical plant which the MRP program can implement to drive purchase order and work order requirements.

One final issue is that the operational departments of the company be structured for control and economy with the master schedule with its inputs from sales forecasting and finance driving the MRP, which provides further specific direction for purchasing and production. It is necessary that the operational departments of the plant be structured so that a scheduling department or production inventory control department be intimately tied to the forecasts, etc. The computer and the MFG/3000 package will take the master schedule demand and provide information which may be directly inputted into purchasing and production scheduling. Conflicts in the schedule and the master plan must be resolved by the scheduling, purchasing, and production departments. In some cases, the master schedule must be revised due to the inability of purchasing and production to accomplish the goals. On the other hand, the system also provides quantitative feedback to anticipate and measure capacity limitations. These limitations, if pointed out in advance, may, at the option of management, be resolved to meet the master schedule if its requirements are paramount to these defined limitations.

Our feeling after using the package for approximately six months is that it provides extremely useful and flexible tools for purchasing, warehousing, and production to accomplish their objectives. It provides qualitative tools for management to evaluate operational departments in terms of inventory value, inventory turns, back order analysis, shortage analysis, and materials requirements. These may be used by the operational departments to evaluate their own members and by management to evaluate their

operating departments. The MFG/3000 package is entirely materials-oriented, and its biggest limitation is simply that it encompasses the materials portion of the manufacturing plant's operational system. It provides only slight support for labor and routing information and provides little or no support for the financial department. The package may be enhanced best by further development of product costing, job costing for the materials area, and the development of a master schedule system to ease the development of master schedules and inventory control. Obviously, to encompass all the elements of the manufacturing plant, an accounts payable package tied to the purchase order portion of the IOS package is desirable; and on the other side of the master schedule module, an order entry and accounts receivable package would greatly round out the whole system. Of course, standard accounting functions, such as general ledger, etc., should be provided to tie the whole system together.

In summary, the package has been found to be extremely easy to use and is easily implemented by the operational departments. The design is relatively simple and straight forward so that it solves a large number of the operational problems of the manufacturing plant without embroiling the departments in embellishments which detract from the objective of this system—which is to increase the efficiency and operational effectiveness of the manufacturing plant.

In many MRP-oriented systems, the goal of increased efficiency is obscured by "bells and whistles," which reduce the effectiveness of the computer-oriented system. The MFG/3000 package, in a simple,

straightforward approach, has addressed the materials problems of the manufacturing plant in a very successful manner. We strongly recommend that Hewlett-Packard continue with this approach and encompass the above-mentioned additional areas to provide an inclusive package for the manufacturing plant.

IV. MFG/3000 From The System Administrator Point of View

A. Installation. As discussed in the previous section, installation was a fairly non-traumatic process. Vetter had the advantage of implementing first at the California plant which was in the process of being established and is considerably smaller than the Illinois plant. In addition, since the computer system was on-site, communications problems were not involved. Implementation of each package for the Illinois plant followed California installation by about one month. Both installations pointed out the need for careful planning, particularly during the loading of the EDC data base. For the System Administrator, early establishment of the default values for the various data items associated with parts is very important. Although direct use of QUERY can be used for some simple changes to large numbers of parts, such updates must be done extremely carefully. Later, QUERY was used indirectly for massive updates by using it to create a transaction file containing all needed changes for EDCMAINT. Such a technique can also be used to more easily request reports pertaining to large numbers of parts, instead of requesting the report for each individual part number through EDC. For example, one can request a bill-of-material for all parts meeting certain criteria. It is recommended that forms similar to the EDC screens be designed to simplify and control initial data entry.

As is typical, most errors are discovered during system use, so one can expect to detect most of the errors in EDC during the early months of IOS use.

Another problem was encountered during the installation of the Illinois plant. Although MFG/3000 is installed by HP assuming a MGR.MFG3000 user and account, with two plants two different accounts are needed (each plant has its own MFG/3000 data base). In addition, to save disc space and CST's, we decided that only one copy of MFG/3000 programs would be stored for use by both plants. With all programs stored in one plant's accounts, the other plant needs the work files, its own data base, the forms files, and its own copy of the JCL (or STREAM) files. These files are modified as follows:

1. The PGM= parameter of the EDC3000 and IOS3000 screens (the first screens of the modules) must be changed to a fully qualified program name in the "program" account. This is easily done through FORMAINT.

2. All JOB user and account names must be changed to that of the plant.

3. All RUN statements in JCL and those of on-line users must be changed to fully qualified program names.

4. The access security on the program groups must be changed to ANY for execute. A similar change may have to be made in the account in which the programs reside.

Adequate security between plants is maintained since file references default to the log-on account, and this also causes

our recommendation that these courses be attended only by people who were already educated regarding computers and manufacturing, thus reducing the chance they would degenerate into introductory courses.

We found the quality of the courses, instructors, course materials, and documentation to be very high. Each course lasts two to three days, and much material of practical worth is covered. We had an advantage in that the implementation of each module was actually accomplished before the corresponding course was attended, but that just increased its worth to us since problems we had encountered and "tuning" issues could be discussed. There was considerable lab work, although some was simply rote. There is a significant advantage in having a "live" terminal in front of each student to test functions as they are discussed.

The system specialists in MFG were also (and continue to be) invaluable, as problems occur particular to our installation. Telephone calls average one or two a week, and we are visited at least once a month. This frequency is expected to diminish over the next half-year.

C. Customization. Vetter purchased the object code version of MFG. The source code version costs considerably more and is not maintained by HP. Despite this, MFG offers some customization abilities.

Screens may be modified under certain conditions. Alternatives may be added to menu screens, including branching to user-written routines. Fields that exist in the standard MFG data base may be

added to data entry (FMT) screens and non-key fields may be deleted from those screens. The order of existing fields may not be changed. Fields added to the data base by the user may not be added to the screens.

Data retrieval (RET) screens, for all practical purposes, may not be modified except to move fields (maintaining the same order) and to change protected fields.

The new user may become somewhat confused by MFG's use of the NEXT= parameter of a DEL screen, which usually indicates the next screen in a sequence. In MFG it indicates the previous screen, and is used to "back up."

Field editing may be changed within the different alternatives offered by MFG (such as alphanumeric, numeric, etc.) as long as the new editing is more restrictive. The size of fields may be diminished.

We have modified the JCL streams often, particularly with the MRP module. Up to 15 levels of planning are available; Vetter uses only seven. Since the analysis routines are performed by chained STREAM commands, one need only change the last STREAMs of the last level desired, e.g., MRP2007J, to chain instead to the last jobs of the MRP process (MRP2100J and MRP2400J). In addition, MRP2400J must be modified to turn the FILE and SORT statements for unused levels into comments. Finally, the FILE statements in the last MERGE are likewise deleted. Thus, to add another level of planning is a relatively simple process of removing comment indicators.

It is difficult, if not impossible, to modify MFG off-line reports. QUERY has proved to be an invaluable tool in this regard. In addition to the technique of producing a transaction file described above, QUERY is extensively used directly for producing a multitude of periodic and ad hoc reports. Purchasers should be cautioned, however, not to permit any except trained technical personnel to use QUERY for updates. It is very easy to get the data base in such a state that the pointers, etc., are in very bad shape. Additionally, updates lock the data base for a long time. In general, avoid using QUERY for anything except retrieval.

D. Security. Probably one of the weakest aspects of MFG is its security provisions. There are essentially four levels of security: the MPE account structure, file lockwords, MFG originator numbers, and data base passwords.

The MPE password security is of limited value since it must be known by large numbers of plant personnel to enable them to use the system. Lockwords on user programs suffer from the same problem, although all our System Administrator routines are so protected.

Originator numbers must be entered by the MFG user before access to most on-line functions. Some data retrieval and report requests do not require originator numbers. These numbers, ranging from 0 to 99, are assigned to individuals and groups and are used for distributing the Transaction Register Report of EDCMAINT and for controlling the functions that may be performed using each screen. An originator may have any of three capability levels:

1. None

2. Modify

3. Add/Delete (which includes Modify)

Although access rights are assigned through MFG by fields, we have found it more practical to regard the capabilities to be attached to screens since to effectively use a screen, one must have the same capability for all fields on that screen. Any particular originator must have Add/Delete capability for all fields associated with him, not just a subset.

Originator numbers do have some limited value in protecting against inadvertent but unauthorized behavior, but they have almost no value in protecting against intentional misuse. Originator numbers are restricted to only 100 alternatives and are printed on so many reports that acquiring one seems a very easy process. We have recommended to HP that the originator number be alphanumeric. Although we were told that we could have 100 originators as long as we had only 20 variations of capabilities, we discovered that only 20 originators are allowed, regardless of capabilities.

The system is installed with a system administrator originator number with complete capability (in fact, there are numerous originators existing on the originally installed system which might be deleted). It may be best not to have any originator with such capability, and only create it when needed. At the very least, the standard administrator number should be changed since it is published in HP documentation.

A major criticism of the security is the data base protection. Any user with the logon password and the data base password can easily access (and update) the data base using QUERY. Unfortunately, there is one master password for write access to all fields in the data base. This password is common to all three MFG data bases, is the same for all MFG installations, is not at all cryptic, and even worse is published in some HP literature! For the purchaser with dial-up capability, a major vulnerability exists with regard to the security of the data base. We have recommended to HP that a unique password be established for each installation.

E. Production Operation. There are many batch jobs that must be STREAMed to maintain the system. Data entry in EDC does not directly update the data base, but rather appends a record to a transaction file which is later used by the batch job, EDCMAINT, to perform the updating. EDCMAINT also produces the off-line reports. IOSO400J strips certain information from the EDC data base and updates part information in the IOS data base. Other batch jobs update the Edit Tables (which define screen field editing and originators), delete parts from the IOS data base, etc. In addition, we have created job streams for some QUERY reports.

Most of these batch streams require exclusive access to the data base for correct operation. EDCMAINT is particularly tricky, since it repeatedly requests and gives up exclusive access. If someone logs into EDC between such accesses, EDCMAINT can abort in the middle. It is not a big problem to restart it in the aborted place, but it must be done with care and is an inconvenience. In

general, all batch jobs are run after working hours and/or during lunch. There is a slight modification to the EDCMAINT jobstream that will prevent logons during its execution; but this poses some additional problems if an abort occurs for other reasons. And, since the MFG programs are shared by both data bases, this prevents users of the other data base from running EDC. One then tries to insure that all users of MFG are logged off prior to STREAMing EDCMAINT. A potential solution is to create two users, e.g., USREDC and USRIOS, one for each module. Another simpler alternative is to ask users to append their name and module in the HELLO command, e.g., :HELLO IVANEDC, MGR.MFG3000. A :SHOWJOB then indicates who is logged on. Without this additional information, one only has the QUIET indication on the SHOWJOB as a guide.

It was originally intended that EDCMAINT would be run only once a day. However, during the first few months after installation, changes were so frequent that four runs in a day was not uncommon. With more users on now and a more stable data base, there are two EDCMAINT runs per day, at Noon and after 5:00 p.m., for each plant. There is a time zone difference between the two plants. Thus, because of the extensive nature of EDCMAINT, users at one plant can experience a noticeable degradation in response time when EDCMAINT is being run for the other plant.

To reduce such degradation, one may remove from EDCMAINT the job steps which update data sets for which the System Administrator is certain no transactions exist. For example, Vetter does not yet use the workcenter or routing data sets. Clearly, such a modification must be done with care.

In addition, STREAMing I0S0400J (which updates the IOS part information from EDC) has been appended to the end of the EDCMAINT jobstream so the IOS data base is always current with the EDC data base. All scheduled off-line reports are then run after the completion of EDCMAINT.

It is very important that the System Administrator monitor the EDCMAINT runs since we experienced frequent aborts and erroneous data entries during the first months of operation. The aborts were not due to program bugs, but rather to something wrong with the input data or data base. The JCL comments and abort messages are very extensive and helpful. However, it is important to insure that EDCMAINT runs to completion before permitting users to initiate EDC again. The Transaction Registers should be distributed promptly to the originators after being reviewed by the System Administrator for serious or frequent errors. We tried to insure that all users completely understood how to interpret the Transaction Register Report and that they kept all copies on file.

In particular, during the initial months of use, the System Administrator should monitor the sizes of the data sets of each data base. This may be easily accomplished using the DBSTATS routine. Capacities should be adjusted so the data sets are approximately 70% full (or less).

Periodic DBUNLOAD and DBLOAD of a data base can also contribute to improved response times. In a multiple disc installation, it is preferable to place the root file on one disc and the data sets on the other, thus reducing disc contention.

F. Multi-Plant Operation. The modifications necessary to the JCL, etc., to maintain only one copy of the programs in a multi-plant environment has been discussed in Section IV.A. Three problems remain for the remote plant:

1. To direct printed output to the remote line printer

2. To be able to defer the printing of certain reports for the loading of special forms, for large reports, etc.

3. To be able to view the JCL listings resulting from a STREAMed job to check on the occurrence and reason for an abort, etc.

Initially, we installed a "minispooler" provided informally by HP. This routine solved the first problem, but not the other two. Understandably, frustration was high at the remote site.

In the fall of 1978, the minispooler was replaced with the RSPOOL package of DataCon of Oregon, resulting in the solution of all three problems indicated above.

The JCL for the remote site's MFG system must be modified in the following manner:

1. Add the OUTCLASS = LP,1,1 clause to all JOB statements. This specifies 1 copy and an OUTPRI of 1.

2. After the FILE statement for the report file, a set of about 10 lines must be added to initiate and control the execution of the routine SPOOLCOM. This connects the report file to the remote printer, specifies the number of copies, and permits the report file to be held after printing.

3. After each execution of SPOOLCOM, there must be inserted a set of lines which initiate and control the execution of RPOOL. This sets such parameters as lines/form, number of lines between forms, etc.

If the OUTFENCE of the system is set to 1 or greater, the JCL of the remote plant will not print on the system printer, but will be held in the spool files. The remote plant then uses SPOOK to look at the JCL files for a solution to the third problem indicated above. Since SPOOK permits access only to the JCL of the logon account, such users do not have access to the JCL of other accounts. SPOOK permits the user to list the job numbers of the JCL currently in the spool file, which then may be used to display the JCL of the job. The users must periodically purge the JCL files in the spooler so that it does not fill.

If the parameters of the RSPOOL and SPOOLCOM executions are set appropriately, the printing of a report at the remote site may be deferred. SPOOLCOM may then be used on-line to alter file specifications in order to initiate printing when ready or to delete a report file.

We have experienced great satisfaction with this arrangement. Essentially, it grants to the remote site all the power (and then some) of the on-site installation.

G. Backup. One of the most important jobs of the System Administrator is scheduling and supervising backup procedures.

Vetter does a partial backup each night, with a full system backup once a week. Currently, the MFG data bases are not separately backed up using the DBSTORE program, although this will probably be implemented shortly since restoring from the SYSDUMP tape is less reliable and slower.

The transaction file of EDC provides some roll-forward capability, since the last five transaction files are automatically

saved. However, this requires that a copy of the data base corresponding to its state prior to the EDCMAINT run be available. If EDCMAINT is run twice a day and backup is performed only once, roll forward can be done from only two or three backup copies, not five. However, it is possible to modify the EDCMAINT JCL so that more than five transaction files are saved.

IOS automatically provides a journaling of all transactions which affect the data base. The documentation is very unclear as to how to control this capability. In summary, the logging in IOS is always running. The only control the user has is to which device the logging is directed, disc or tape. Normally, we log to disc. Twice a day, STARTLOG is run to dump the current contents of the disc log file to tape, which also directs any future log transactions to the tape. After the disc file has been dumped, STOPLOG is run to direct future logging to the disc. We insure that no one is logged into IOS during the time STOPLOG is run. Besides insuring that the log file is large enough to contain the number of transactions likely to be entered between tape dumps, that is all there is to it. There is a utility to display the current number of log entries in the file so that it can be monitored. Our volume is easily accommodated on a 1200' reel.

At the current time, IMAGE does not provide any journaling capability; thus roll-forward and roll-backward are not available outside of the MFG facilities.

Another backup capability may be provided by the HP 2645A terminals themselves if they have the tape option installed. If

the computer system is unavailable, or data entry takes place over a slow speed data line, the data may be loaded off-line through the terminal onto a tape cassette, then dumped to MFG in a rapid fashion. In order to prepare for this process, store the MFG screens on a tape cassette, (by displaying a screen, then in local mode copying to tape). Later, in LOCAL mode, display the selected MFG data entry screen by copying from tape to the screen. Put the terminal in format mode using CTRL f_4. Enter the data normally. Pressing the ENTER key will copy the unprotected fields to the tape and clear the screen. Data entry may then continue in a similar fashion. Conclude by releasing format mode using CTRL f_5.

In order to enter the stored data, log on to MFG and display the appropriate data entry screen. Copying a record from tape to the screen and then pressing ENTER will cause MFG to read the screen in the normal manner.

V. Implementation of an Order Processing System

SDA and Vetter are currently implementing a comprehensive order processing system (OPS) to interface with MFG/3000. The overall structure of the system is shown in Figure 2. It consists of the following elements:

1. Part Element—To maintain descriptive and availability information about each part that may be sold.

2. Dealer Element—To maintain information about each customer.

3. Order Entry Element—For the entry, review, modification, and reporting of information about orders.

4. Pick List Element—To produce pick lists on a selected basis.

5. Shipping Element—To produce invoices and other shipping documents.

6. Accounts Receivable Element—To maintain accounts receivable information relative to orders and dealers.

7. Warranty Element—To maintain information about the product and the end purchasers.

The Part Element operates much like IOS in that it strips relevant information from the EDC and IOS data bases and puts it into the OPS data base. This continues the MFG policy of maintaining data base separation between major functions. Because IMAGE permits locking only at the data base level (but see Section VI), separate data bases permit an acceptable response time in a multiple user, on-line updating environment at a cost of duplication of data and increased storage requirements.

In addition to the obvious on-line functions, there will be numerous reports (well over 20) provided.

The major contribution of this system will be timely indications of the ship date of an order through consideration of planned receipts of finished goods and shipping rate limitations. We expect to be able to predict ship dates within a day's accuracy at the time of order acceptance. Information concerning planned receipts will be acquired directly from the master production schedule driving MRP or from the work orders and purchase orders of IOS. Thus, any change in production schedules will be immediately reflected in changed order ship dates.

During this implementation, we realized that although MFG and IMAGE will permit the user to add data fields to the end of data sets, this was a dangerous practice. Future versions of MFG could very well expand the number and size of data fields. The addition of custom data fields could prevent the easy updating of MFG, requiring special programs to unload and load the data base (since the new HP fields would have to be "inserted" between the standard and the custom fields), and the custom programs would also have to be changed. This was another major reason that we decided to implement a separate OPS data base.

There are four interfaces between the two systems:

1. Moving part and inventory information from MFG to OPS
2. Acquiring the master production schedule (MPS)
3. Acquiring the shop calendar
4. Updating the inventory counts as a result of shipments

Acquiring part information is a very easy task. The Part Element has produced the side benefit of insuring that the EDC data bases of the two plants contain the same information about the same part number.

We have not yet finalized the method of acquiring the MPS. This is relatively difficult to acquire directly from IOS. We considered having each plant manager create an EDITOR file, from which we would generate appropriate transactions to IOS for MRP to OPS. However, this seems too complicated. Our judgment now is to simply scan the IOS data base for work orders for finished goods and create corresponding allocation data records in the OPS data base. Since the factory works directly from these work orders, we would be using the best information available. This would free the plant manager to use the input of a MPS to IOS as a planning and "what if" tool. Finally, it encourages the plant managers to plan their production schedule out to the horizon of shipment planning.

MRP generates a ship calendar which we plan to use directly for assigning order ship dates. In this manner, we can easily take into account holidays and weekends.

Finally, since IOS provides no method (other than stock adjustments) for drawing down finished goods inventory, the OPS system must create a transaction file of stock adjustment requests that a MFG batch job uses to update the inventory levels in IOS. In addition, OPS generates an Issued Goods Report for cross-checking IOS stock activity records.

All of these interfaces have been relatively simple and easy to implement. It appears that MFG lends itself very well to supporting user-written custom programs. The required MFG documentation is very adequate and clear.

We have experienced two problems with the use of DEL in this implementation. Since DEL does not permit field-level reads and writes, the entire contents of the unprotected fields must be transmitted, even if only a subset of the fields is desired. In a remote terminal environment, this tends to radically increase communications line load, and if the terminal is slow, response time can suffer. Our only current solution is careful design of screens.

The other limitation appears to be in FORMAINT. The OPS employs a few screens where there are a considerable number of enhanced, unprotected fields. We have discovered that FORMAINT (and DEL) will accept a maximum of 1920 characters, including the ESCAPE sequences for the fields. Since there may be as many as 10 characters associated with a field just for the enhancements, this limit can rapidly be reached. Although the 2645A terminal may support a form, FORMAINT may not. Our only current solution is to give in and reduce the number of fields.

VI. Potential and Recommended Enhancements

Enhancements from the user point of view have been discussed in Section III. This section will focus on improvements from a System Administrator view.

With the announcement of the new IMAGE with record-level locking, we can expect the merging of the three MFG data bases into one. This should produce significant improvements in storage requirements and some improvement in user response time (since interactive programs will no longer be locking the entire data base). Some operational problems (such as exclusive access aborts) may be reduced. The batch programs that move information from one data base to another will be eliminated. EDC may be converted to an on-line updating system.

Because of the problems associated with MFG updating, we plan to maintain a separate OPS data base, but record-level locking will produce very significant operating improvements in order processing. The impact of VIEW/3000 as a substitute for DEL is unknown at this time due to the lack of documentation. However, the ability to do field level read/write would reduce communication loads considerably. We would also like the size limit on forms to be at least increased, if not eliminated. A significant improvement to DEL would permit the selective modification of a form, without re-entering all the edit specifications. In addition, it would be nice to simply state that no edit specs existed for the entire form, thus skipping laborious entering of X's.

Although MFG provides some journaling, we would like to see the logging from IOS and EDC better coordinated and similar. Roll-back abilities would be nice. Eventually, it would be best to have such recovery facilities built into IMAGE so user-written programs could take advantage of them.

The OPS would benefit by a better method of entering the master production schedule than as a series of work orders.

However, the two major limitations of MFG/3000 are its security provisions and the high number of CSTs it demands. The security provisions were discussed in Section IV. Despite the large size of the Vetter system, it frequently runs out of CSTs, particularly during a COBOL compile. This is because both COBOL and MFG make high demands on this limited resource. In a multi-plant environment, we have doubts that we could oerate if a copy of the MFG programs were required for each plant. This limitation has forced us to violate the generally accepted HP3000 practice of small routines in the implementation of the OPS, with its attendant problems of long compiles and decreased system performance. We expect that MFG's high use of CSTs will be alleviated in future updates.

VII. Conclusion

Both as user and system administrator, we have found MFG/3000 to be a well-designed, reliable, well-documented, and "friendly" system, with a few relatively minor limitations. Installation proceeded remarkably smoothly and rapidly. Users became quickly familiar with the system. The addition of custom systems that interface with MFG is straightforward. And, lest we forget, it also has resulted in improved plant operation and customer service.

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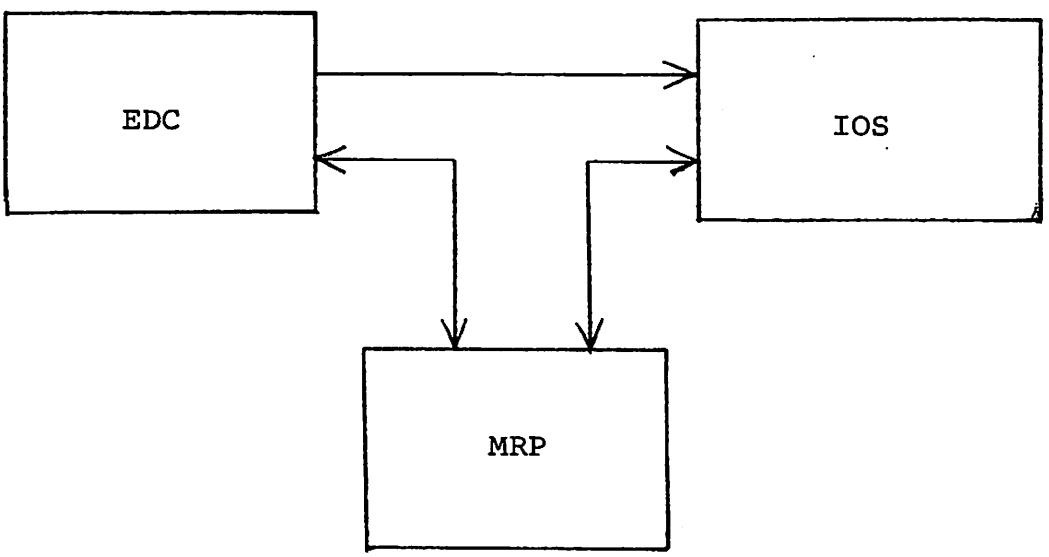

FIGURE 1. MFG/3000

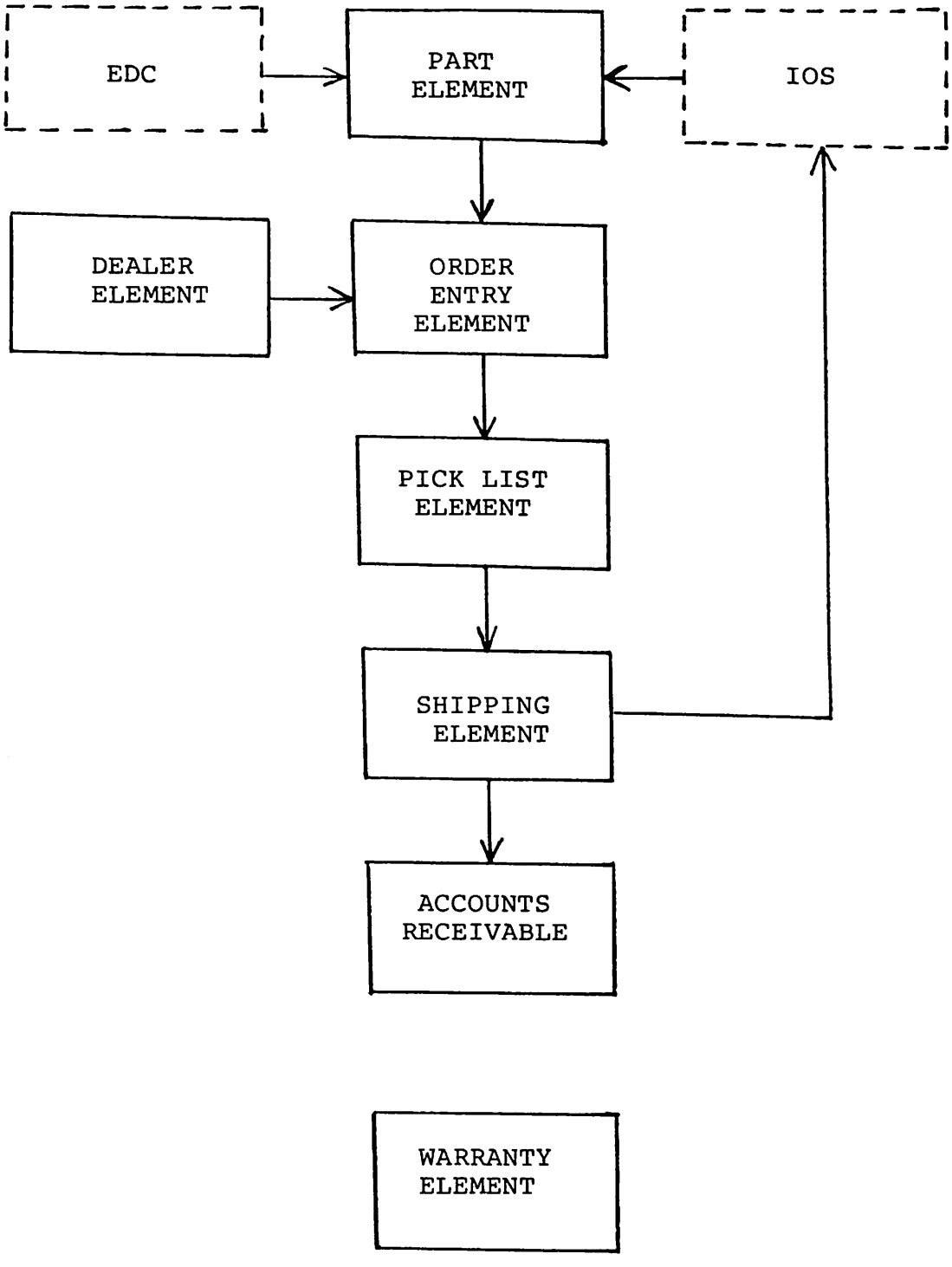

FIGURE 2. THE ORDER PROCESSING SYSTEM (OPS)