SYSTEM/3

GH20-0971-2

System/3 Inventory and Requirements Planning Application Description

Program Product

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System/3 Inventory and Requirements Planning Application Description

Program Number 5702-M52

A manufacturing organization requires that all parts, both manufactured and purchased, be available to meet production schedules demanded by finished product due dates, and that a sufficient quantity be available to satisfy demand. Manufacturing must also be able to quickly adjust its forecast on the basis of changes to customer orders. In addition, there is a need to maintain inventories at an optimum level so as not to incur the costs of obsolescence, unneeded warehouse space, unnecessary inventory, insurance, and purchase charges. System/3 Inventory and Requirements Planning is designed to satisfy these requirements and needs. The system is capable of:

- Classifying inventory items
- Computing safety stock and order point
- Projecting demand on the basis of historical data
- Planning economic order quantities
- Determining net finished product requirements
- Offsetting requirements by considering lead times
- Transaction processing
- Maintaining and updating the requirements plan by processing changes to forecasts and orders (referred to as requirements alterations)
- Providing for management review through detailed stock status and requirements reports and exception notices

The audience for this manual includes customer executives, systems analysts, and programmers. The manual contains information necessary for the potential user to determine applicability and to begin planning for implementation of the system.

Program Product

Third Edition (March 1973)

This edition, GH20-0971-2, is a minor revision of GH20-0971-1 incorporating TNL GN20-2842 and other small changes. It does not obsolete GH20-0971-1 as updated by that TNL.

This edition applies to Version 1, Modification Level 0, of the program product Syst Inventory and Requirements Planning (5702-M52) and to all subsequent versions an modifications until otherwise indicated in new editions or Technical Newsletters.

Changes are continually made to the information herein. Therefore, before using this publication, consult the latest System/3 Bibliography (GC20-8080) for the editions that are applicable and current.

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PREFACE

The System/3 Inventory and Requirements Planning application description begins with two basic elements--informational requirements and relationships of production data. Throughout this application description, it will be shown how System/3 Inventory and Requirements Planning may be used to provide answers to the following questions:

1. What raw materials, parts, subassemblies, and assemblies are required?

2. Which of these parts, subassemblies, and assemblies must be manufactured or purchased?

3. Of the required materials that must be purchased or manufactured, how many should be ordered or produced, and in what quantity?

4. When should the required materials be ordered, purchased, or manufactured so as to provide the items in time to meet forecast product due dates?

Several factors permit solutions to the problem of mechanization in this area: (1) The System/3 Bill of Material Processor program which provides the file organization and maintenance necessary for the common data base required by a production information control system, and (2) the System/3 direct access storage devices which provide the efficient random processing necessary in this application area.

System/3 Inventory and Requirements Planning is designed to provide control of inventory and to determine product requirements. The program product can be adapted by users not in a manufacturing environment who desire only the inventory management capability. The data base in this case need only include the item master file which can be organized either by using System/3 Bill of Material Processor or the indexed file organization capability of System/3 Disk System RPG II. For this situation, the execution of the programs which pertain to the requirements planning phase is not necessary.

System/3 Inventory and Requirements Planning provides a logical step in the overall orderly growth plan for a manufacturing organization with the objective of doing a better job of managing materials, money, men, and equipment.

A definition of many of the terms used in this manual may be found in the Glossary.

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INTRODUCTION

THE ENVIRONMENT

TYPES OF COMPANIES

Manufacturing industries are classified into three categories: (1) basic producer, (2) converter, and (3) fabricator. The basic producer uses natural resources to produce raw materials for other manufacturers; for example, a steel company processing iron ore to produce steel ingots. The converter, on the other hand, uses the products of the basic producer and changes them into a variety of industrial and consumer products. He takes the steel ingots, for example, and converts them to bar stock, tubing, or plate. Finally, the fabricator takes the products of the converter and transforms them into a variety of other products, such as nuts, bolts, shafts, etc. For example, the fabricator assembles engines, frames, wheels, and other items and transforms them into a finished lawn mower.

METHODS OF PRODUCTION

The fabrication industries further break out their operations into the job shop, the assembly (or product) line, or a combination of the two.

The job shop is the intermittent type of operation. Departments or work centers are organized about particular types of multipurpose machines to perform a specific function. Individual work centers exist for drilling operations, milling, facing, etc. Because of the profusion of centers, control of work in process becomes a burden. Order expediting, scheduling, and machine setups further complicate the job shop operation. Such an environment inevitably calls for extensive paperwork to closely control costs and productive capacity.

The assembly line is described as a continuous type of operation. A uniform flow exists within a physically contiguous area. Although paperwork is less burdensome, the line is very sensitive to disruption due to breakdown.

The third or combination process calls for departments to be laid out in an operational sequence on the basis of product specialization. As a result, a single direction of flow exists from one department to another.

TYPES OF PLANNING

Orders are separated into make or buy items. To-buy material falls in the domain of the purchasing department. To-make orders are scheduled into the fabrication shops and the assembly line. The to-make orders can further be divided into make-to-stock or make-to-order categories. Finished stock orders are directed to the warehouse as standard or stock items. They may also become slightly modified by the addition of certain options or features. Make-to-order material is custom-built or custom-assembled and reflects an individual customer's requirements.

It is for these types of fabrication companies that System/3 Inventory and Requirements Planning has great value because the companies have some or all of the following characteristics:

1. The finished product is usually complex, and may be composed of components from many levels of manufacturing.
2. The finished product is normally expensive; strict control is desirable.
3. There are multiple uses of components and subassemblies with significant value being attached to each.
4. Consolidation of requirements (lot sizing) is necessary to reduce purchasing and manufacturing order costs.
5. The finished product manufacturing cycle is relatively long.
6. Raw material or semifinished components are stocked.
7. Component and raw material lead time is relatively long.
8. A large inventory of component parts is maintained.

THE MANUFACTURING ORGANIZATION

MANUFACTURING PROBLEMS

The manufacturing organization is plagued with a combination of problems that differentiate it from most industries. Manufacturing is a costly business, its product is complex, the company undergoes heavy competition, and it operates in an ever-changing environment. The manufacturing environment expands and contracts with great frequency. A new product line may require additional capital outlays involving new plant or warehouse sites, the addition of second or third shifts, the hiring of more workers, or plant layout changes. There are growth pains--periods of contraction and expansion with accompanying layoffs, hiring, and training. Management, therefore, needs the ability to plan ahead to meet the impact of the changes and schedule manpower, material, and equipment to the advantage of the company.

MANUFACTURING NEEDS

Experience has shown that manufacturing requires a central information system that provides a framework to facilitate mechanization of a production control system. The accumulation of information should be concentrated in a production information center where, literally, one set of books is maintained. This takes the form of records stored on direct access files, readily accessible to all interested parties at a moments notice. These records should be designed to contain as much data as is deemed important to management. Accurate records are an essential requirement of the system. With a common data base it is easier to maintain accuracy. The System/3 Bill of Material Processor program product (5702-M41) provides excellent techniques for organizing and maintaining the basic file records and retrieving necessary information from them.

INTERFACE WITH A PRODUCTION INFORMATION CONTROL SYSTEM

Before discussing System/3 Inventory and Requirements Planning it is best to place this function in its proper perspective relative to a production information control system. Figure 1 shows this relationship.

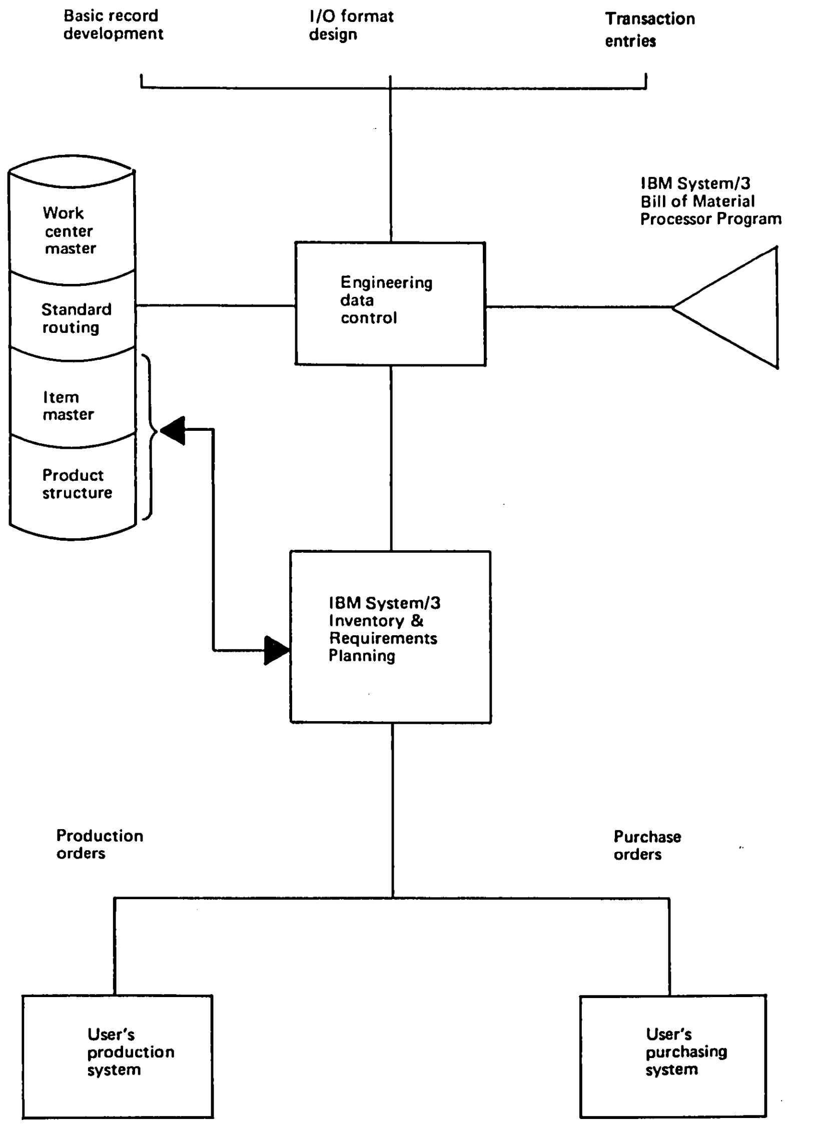


Figure 1. Inventory and requirements planning interface with a typical production information control system

Gross requirements for end items and replacement parts stored in the item master file can be projected by System/3 Inventory and Requirements Planning on the basis of past demand.

Product requirements specifications are translated into gross requirements for parts and subassemblies by exploding and summarizing bills of material. The bills of material or structures of products are stored on the product structure file. Component requirements are distributed over the proper time periods by level and offset by the manufacturing lead time. The accumulated gross requirements per item are checked against stock on hand and on order to determine net requirements. Order quantities and required order start dates are then determined by System/3 Inventory and Requirements Planning on the basis of net requirements. Item requirements normally purchased are sent to purchasing, and information for those items normally made are sent to a production planning function and may then be entered into a capacity planning system.

Order schedule information provided by the capacity planning system may be used to establish input to an operation scheduling system or a shop floor control system. A conceptual discussion of these three systems is found in the manual entitled The Production Information and Control System (GE20-0280).

EXTENT OF COVERAGE

System/3 Inventory and Requirements Planning consists of a group of programs developed to assist manufacturing companies in the installation of an effective inventory and requirements control system. The programs are grouped into four phases: (1) inventory planning, (2) projection, (3) requirements planning, and (4) execution.

INVENTORY PLANNING PHASE PROGRAMS

- Inventory analysis - usage extension
- Inventory analysis - report
- Inventory analysis - classification
- Inventory analysis - update
- Order point
- Order quantity

The inventory planning phase programs are provided to assist management in their judgments regarding the type of control to be exercised for the inventory items. In addition, the programs calculate economic order quantity, order point, and safety stock for inventory items on the basis of usage data and the type of control that is selected.

PROJECTION PHASE PROGRAM

- Update and project

The projection phase program projects future usage on the basis of certain parameters provided in a parameter record and read by the program. This program also provides for keeping the information current so each projection or forecast can reflect the latest information.

REQUIREMENTS PLANNING PHASE PROGRAMS

- Initialization
- Requirements generation
- Requirements report
- Exception report

The requirements planning phase programs take advantage of one of the most advanced and exacting analysis techniques--the time series level-by-level analysis approach (which is especially applicable where a product has multilevels of production, high-cost components, long lead times, stocking of semifinished components, and/or multi-use assemblies and parts) to fulfill the requirements of the overall plan.

EXECUTION PHASE PROGRAMS

- Transaction processor
- Status report

The execution phase programs provide for processing the day-to-day transactions that must be recorded in the item master file. Two programs are provided for updating the item master file and for preparing reports.

System/3 Inventory and Requirements Planning uses the item master and product structure files that are created and maintained by the System/3 Bill of Material Processor Program. The output from System/3 Inventory and Requirements Planning is in the form of planned orders for purchased and manufactured items. Planned orders for items to be manufactured are available for input to a capacity planning function, and planned orders for items to be purchased are available for input to a purchasing function.

System/3 Inventory and Requirements Planning uses many of the concepts of the inventory control and requirements planning subsystems as discussed in the manual entitled The Production Information and Control System.

All programs in the package are designed in such a way that the user can easily modify them to meet the specific requirements of his installation.

As an additional aid to the user, a summary outline appears after the discussion of each phase of the program application.

OBJECTIVES

The objectives of System/3 Inventory and Requirements Planning are to provide an approach to control inventory with relative ease; to generate a finished product plan; and to determine the raw materials, fabricated parts, purchased parts, subassemblies, and assemblies needed to meet the finished product plan that has been generated. The term finished product is used to include service or repair parts as well as end products. The aim is to determine requirements as quickly and as accurately as possible, as well as to react quickly to changes in forecasts, order cancellations, or plant rescheduling.

To be generally effective the system should be able to do the following:

1. Classify all inventory items
2. Establish an order point
3. Provide for order point control with automatic generation of order recommendations
4. Consider safety stock
5. Determine finished product net requirements
6. Determine component gross requirements
7. Determine component net requirements
8. Plan requirements on the basis of a predetermined order policy
9. Offset requirements on the basis of manufacturing or procurement lead times
10. React to revised orders or forecasts through requirements alteration
11. Print only information that is desired
12. Allow for selecting only certain options in processing runs, thereby minimizing processing time
13. Provide for variations and flexibility within the system to enable the user to tailor the program to meet his specific needs
14. Provide stock status reports
15. Allow transactions to maintain an accurate data base
16. Provide exception notices for management action

ADVANTAGES

Using System/3 Inventory and Requirements Planning provides the following advantages:

1. A mechanized approach for generating a finished goods plan and determining planned orders by time period for finished products, assemblies, subassemblies, parts, and raw materials

2. A variety of processing options which may be selected by the user:

   a. Projecting demand

   b. Consideration of safety stock, allocated quantity, and shrinkage factor

   c. Planned order policies which consist of discrete, fixed quantity, order point, part period balancing

   d. Modifying planned order policies by considering number of days' supply, minimum-maximum-multiple quantities, and cutoff dates

   e. Offsetting requirements by a fixed lead time

3. Provision for user determination of the type of control based on classification of inventory items

4. Calculation of safety stock and order point

5. Projection of demand based on historical data

6. The ability to evaluate old and new safety stock each time an order point is calculated

7. The ability to contrast the newly computed order quantity to existing order quantity with respect to inventory level and setup costs

8. Availability of two requirements processing variations: complete generation of requirements and requirements alteration (revisions to gross requirements)

9. Provision for a detail report of requirements and an exception report that can be printed after requirements are generated

10. Printing of various detail requirements including item indicative information, gross requirements, open orders, net requirements, planned orders, and offset requirements in the sequence in which the item master file is organized at the completion of generating requirements

11. Storage of gross requirements, open orders, and planned orders in the item master file

12. Input provided from card or disk containing gross requirements by date and quantity

SYSTEM FLOW

Figure 2 shows the System/3 Inventory and Requirements Planning system flow. Within the inventory planning phase, inventory analysis provides for classifying inventory items and initializing information to be used by the order point and order quantity programs which calculate order points and order quantities and update the item master file. The analysis for the implementation aspect of these programs enables the user to vary calculation factors for the purpose of analyzing the possible effects of changing order points and order quantities before actually implementing the changes.

During the projection phase, the update and project program maintains current parameters for each inventory item and projects future usage on the basis of the parameters. This program utilizes the most recent period's demand which is supplied by the system's execution phase.

The requirements planning phase provides for generation of planned orders. This phase uses the gross requirements generated by the projection phase as input, or, optionally, may use customer orders. The input spans a user-specified number of planning time periods into the future. The output consists of planned orders for all items affected by the initial input.

The execution phase updates the item master file from the day-to-day inventory transactions and provides inventory status reports and exception highlighting.

Each program is discussed in more detail on the following pages.

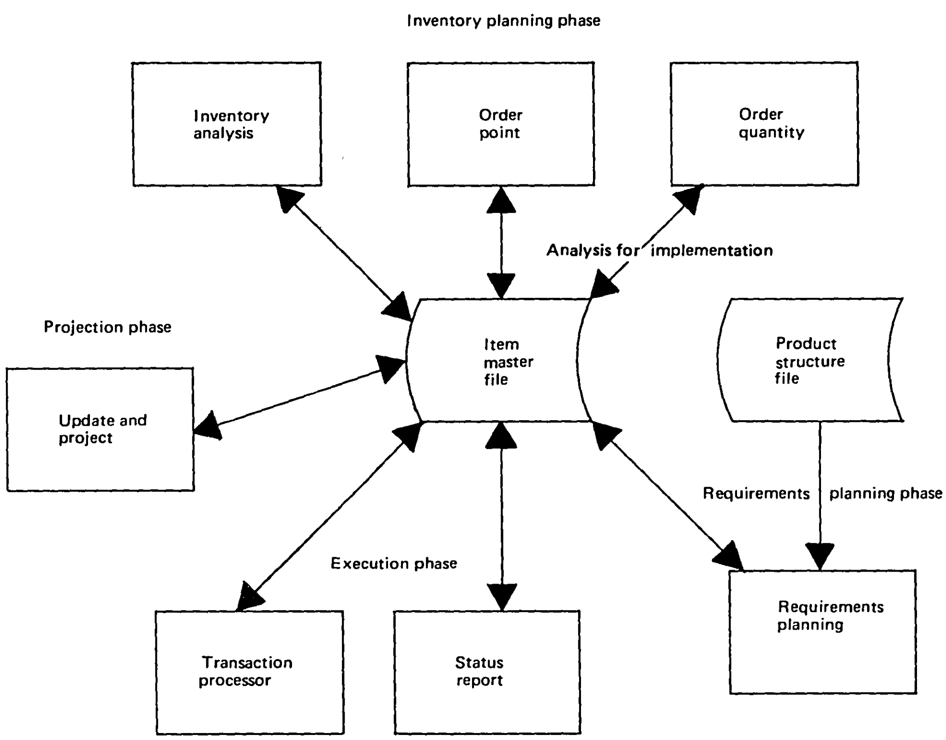


Figure 2. System/3 Inventory and Requirements Planning system flow

System/3 Inventory and Requirements Planning consists of four phases: inventory planning, projection, requirements planning, and execution. Fields of the records described are defined in the section entitled "Files and Organization".

INVENTORY PLANNING PHASE

The inventory planning phase consists of six programs, four of which pertain to inventory analysis. The six programs are:

1. inventory analysis - usage extension
2. inventory analysis - report
3. inventory analysis - classification
4. inventory analysis - update
5. order point
6. order quantity

INVENTORY ANALYSIS

Inventory analysis should be the first step toward the implementation of inventory control. It helps to answer the following questions: "What do we control?" and "How do we control it?".

General experience has shown that a company should not use the same type of control for low-cost stock items that is used for high-value items. If control procedures are the same, perhaps too much is being spent for the control of the low-cost items relative to what might be spent for a slightly higher inventory of these items. Or, perhaps too much time is spent controlling these items, thus neglecting the higher-valued items that should receive more attention. In either event an analysis of the inventory items should point out areas of potential saving and increased efficiency.

Inventory analysis helps to separate the inventory into segments or groups to which various levels of control can be applied. These groupings are generally based on dollar value and annual usage. The investment in inventory that an item represents is determined by the cost of producing the item and the annual quantity produced or used. If these factors are extended for each item in an inventory, the items can be ranked in sequence by annual usage evaluation. A typical breakdown of inventory would show that a high percentage dollar value of annual usage is concentrated in relatively few items, while at the other end, a high percentage of items account for a very small amount of annual usage evaluation.

For example, if three classes were used, a breakdown of inventory might show:

Class	Annual Usage Evaluation	Percentage of Items
A	80%	20%
B	15%	30%
C	5%	50%

This value analysis is sometimes called ABC analysis. The number of classes into which an inventory is divided depends upon the characteristics of the specific inventory and the need for a specific number of classifications. For example, these classes can be used to prepare codes for each item master record for use by the order quantity and order point programs. The inventory analysis classification program can place codes on the item master file on the basis of input transaction records.

The value analysis helps to segment the inventory so that a company can concentrate on the items in which it has the largest investment. The analysis should also influence the selection of the method by which order quantities and order points are established. Some items may be ordered on the basis of exact requirements, while the order quantity of other items may be calculated on the basis of estimated usage. In many cases, safety stock and order point may be calculated using statistical techniques that provide a specified level of service (see the discussion on level of service under the section titled "Order Point Program"). At other times safety stock may be calculated by multiplying average demand by a specific amount of time or by a percentage of lead time. The choice of these calculations and other options regarding inventory policy can be made more effectively after this analysis.

As an example of the types of judgments that can be made to reduce costs, assume the following with regard to an inventory. There are 2000 items whose annual usage valuation (usage x unit cost) is equal to $3,000,000. Each item is ordered three times a year with an order quantity of four months' usage, resulting in 6000 orders per year. Assuming constant usage, the average value of the cycle stock is 1/2 the order quantity value and is equal to $500,000. Safety stock is set at two months' supply or 1/6 of the yearly usage (1/6 x $3,000,000 = $500,000). The average inventory level is equal to cycle stock plus safety stock ($500,000 + $500,000 = $1,000,000). This information is summarized in the upper part of Figure 3.

An analysis of these items indicated that the breakdown corresponded to the percentages cited earlier. The ordering policy is changed in the lower part of Figure 3 so that the A items are ordered eight times a year, the B items three times a year, and the C items only once a year. Note that the number of orders is identical to the previous example, yet the cycle stock is reduced from $500,000 to $300,000. If the safety stock is not changed, the average inventory level is reduced to $800,000 ($500,000 + $300,000 = $800,000). This example is referenced again in the discussion of the order point program.

Class	No. of Items	Usage Valuation	Orders Per Yr.	Total Orders	Order Quantity Valuation	Cycle Stock Valuation
All	2,000	$3,000,000	3	6,000	$1,000,000	$500,000
Safety stock = 2 month supply = 1/6 year = 1/6 ($3,000,000) = $500,000 Total average inventory = Cycle stock + safety stock = $500,000 + $500,000 = $1,000,000						
A	400	2,400,000	8	3,200	300,000	150,000
B	600	450,000	3	1,800	150,000	75,000
C	1,000	150,000	1	1,000	150,000	75,000
	-----	---------		-----	-------	-------
	2,000	$3,000,000		6,000	$ 600,000	$ 300,000
Total average inventory = Cycle stock + safety stock = $300,000 + $500,000 = $800,000						

Figure 3. ABC analysis and order policy

Inventory Analysis - Usage Extension Program

The inventory analysis - usage extension program contains the logic to retrieve inventory records from the item master file and to extend annual usage by unit cost and, where appropriate, unit price. Refer to Figure 4 for a general system chart of the four inventory analysis programs. An output record is prepared by the program which contains the results of these calculations. The output records are sorted in descending sequence by annual usage value using the System/3 Disk Sort program.

Inventory Analysis - Report Program

The inventory analysis - report program reads the sorted records produced by the usage extension program and generates the inventory analysis report. An example of an inventory analysis report is illustrated in Figure 5. All items were not included on the example so that just the indicative profile for the complete inventory could be shown. The horizontal lines were included to indicate the ABC classifications.

Inventory Analysis - Classification Program

The inventory analysis - classification program is used to update the item master record with codes that the user specifies as the result of reviewing the inventory analysis report. These codes are used by the order point and order quantity programs for selecting the proper calculations that are to be performed. They include: value classification code, order policy code, order point calculation code, order quantity category code, and safety factor code. The updating of the item master records is performed on a group basis, that is, all items within a given group are assigned the same codes.

Inventory Analysis - Update Program

The inventory analysis - update program is used to update the item master record codes discussed in the classification program on an individual basis. Any combination or all the codes can be changed for an item. This program permits the user to modify specific items after reviewing the group assignment of codes performed in the classification program.

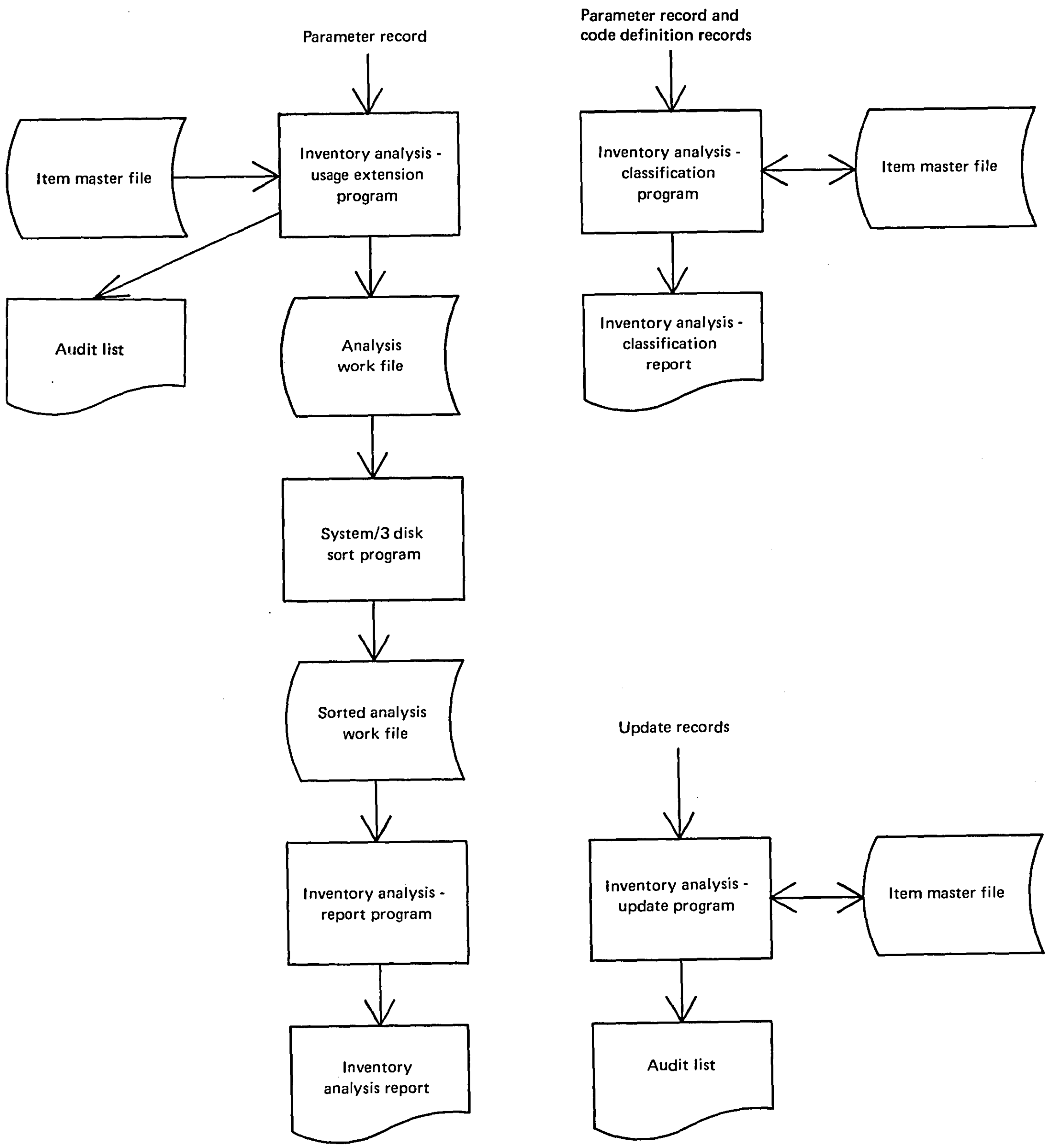


Figure 4. General system chart - inventory analysis programs

INVENTORY ANALYSIS				MANUFACTURING CO			XX/XX/XX	PAGE XXX
ITEM NUMBER	DESCRIPTION	ITEM COUNT	CUM % ITEMS	ANNUAL UNITS	UNIT COST	ANNUAL USAGE $	CUMULATIVE USAGE $	CUMULATIVE % USAGE $
T7061	BLADE ARM	1	.0	14,905	3.077	45,863	45,863	1.5
S7036	ROD BEARING	16	.8	4,250	6.250	26,563	447,080	14.9
G9034	ROTOR UNIT	98	4.9	48,224	.200	9,645	1,203,200	40.1
G9109	FILTER	160	8.0	7,239	.490	3,547	1,653,276	55.1
S5843	CLAMP	280	14.0	2,710	.490	2,981	2,148,358	71.6
S6121	TANK ARM	400	20.0	9,967	.209	2,083	2,400,109	80.0
N3501	SLIDE LOCK	451	22.6	1,138	1.720	1,957	2,493,362	83.1
M2643	JOINT PIN	500	23.5	3,509	.450	1,579	2,523,149	84.1
S7822	CONNECTOR	600	30.0	1,305	.800	1,044	2,634,296	87.8
K2174	CLAMP MOD A	682	34.1	750	1.000	750	2,700,203	90.0
S5904	MOTOR PIN	1000	50.0	1,904	.282	537	2,850,112	95.0
S6219	LEG PIN	1200	60.0	4,520	.050	226	2,895,204	96.5
G4713	BLADE ARM	1400	70.0	3,750	.048	180	2,937,056	97.9
N9773	BRACE UNIT	1656	82.8	1,430	.100	143	2,976,108	99.2
T6613	PANEL SCREW	1782	89.1	198	.505	100	2,988,301	99.6
T6562	TENSION PIN	1884	99.2	210	.143	30	2,997,207	99.9
M3742	RATCHET PIN	2000	100.0	0	.750	0	3,000,125	100.0

Figure 5. Inventory analysis report

ORDER POINT PROGRAM

Some of the most significant decisions to be made regarding inventory control are concerned with order point (when to order) and order quantity (how much to order). These decisions affect the amount of investment for inventory, the level of customer service, and the efficiency of plant operation. Obviously, each company should strive to use the most effective techniques for implementing its ordering policy.

Several methods for the calculation of order point and order quantity are provided in System/3 Inventory and Requirements Planning so that each user can select the techniques that are best suited for his operation. This section of the manual discusses order point; the following section is devoted to order quantity.

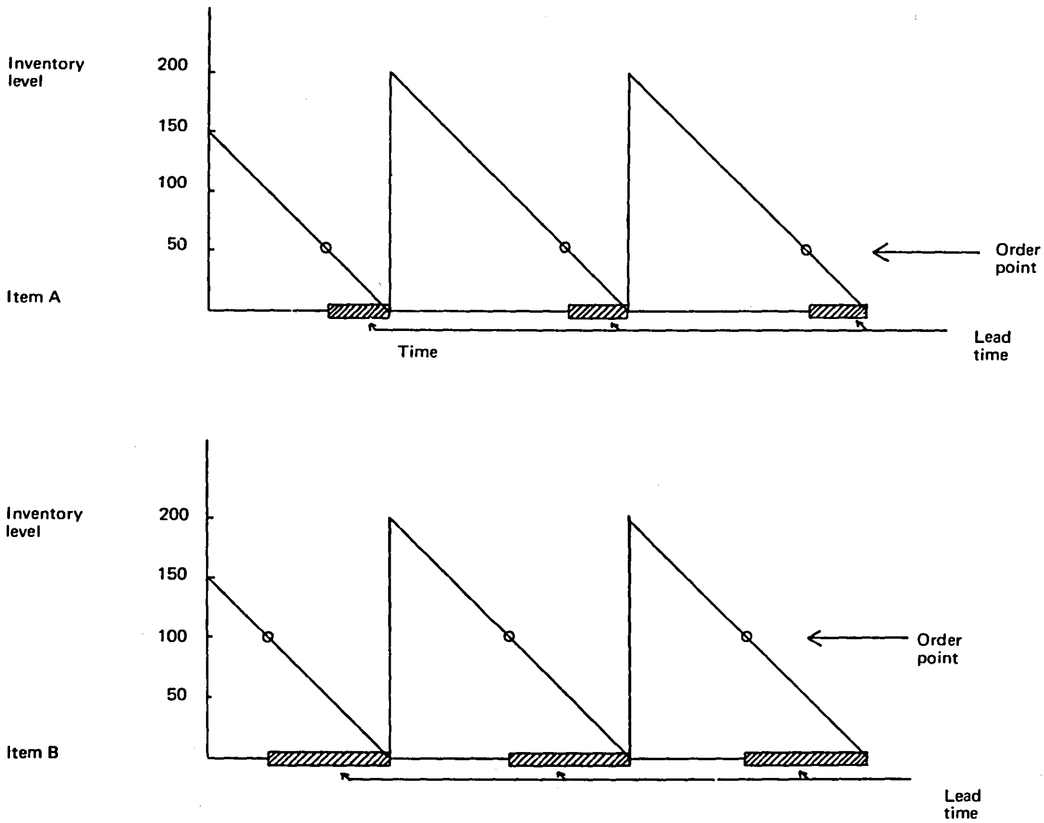
Order Point

Basically, order point is a quantity which, when compared to available stock (on hand + on order), indicates whether a replenishment order should be issued. When the stock is reduced to this point and the order is issued, enough items should remain to take care of the demand until the quantity from the new order is available. Under ideal circumstances, it would be desirable to run out of an item just as the new order is received.

In setting the order point, the two principal factors are lead time, and usage. Lead time is defined as the elapsed time between the issue of an order (purchase or production) and the receipt of the item in the stockroom. Usage is defined as the number of units of an inventory item comsumed during a length of time. Usually, some averaging technique is applied so that actual usage is converted to average usage or average demand which is expressed as a quantity per time period (the calculation technique is discussed in the section of this manual entitled "Update and Project Program"). The formula for order point is shown below:

Order Point = Lead Time x Average Demand

Figure 6 illustrates the relationship of order point, lead time, and average demand. For these examples, the lead time and average demand are for the same time unit. The average demand for items A and B is 50 units; however, the lead time for A is 1 while the lead time for B is 2. Note that the order point is 50 for item A and 100 for item B; this is equal to expected demand for their respective lead times. The order quantity is assumed to be the same for both items.



Item Number	Average Demand	Lead Time	Order Quantity
A	50	1	200
B	50	2	200

Figure 6. Order point based on lead time and average demand

Another factor that can be used in the calculation of order point is review time. Review means comparing an item's order point with the available stock for that item. This is done to determine whether order action is necessary. If the review is done on a periodic basis, or if orders are issued only at specific intervals, there is an additional amount of time between the time an item reaches the order point and the time an order is issued. If the review time is significant, it should be considered in the calculation. Provision has been made for including review time in the program. A restatement of the formula considering review time is shown below:

Order Point = (Lead Time + Review Time) x Average Demand

The use of review time may be clarified by an example of what happens if review time is not considered. Assume that an item is being reviewed weekly. If lead time is two weeks, and usage per week is 50, order point is 100 without the addition of review time. Suppose that available stock is 101 at the time of a particular review; since this is above order point, no order is placed. During the following week, the normal usage of 50 reduces the available stock to 51. An order is now placed, but since lead time is two weeks, the item will be out of stock during the second week. The avoidance of such stockouts would require that review time be added to lead time, making order point 150 in the case cited.

Direct access storage devices make it economical to review the available stock at the time of each transaction; this is often referred to as continuous review. If continuous review is elected by the user, and order action is initiated without excessive delay, the review time can be set to zero, thereby enabling a reduction of inventory. In the case cited above, the use of direct access storage devices would probably eliminate the increase of 50 items.

Safety Stock

Up to now in the discussion of order point, safety stock has not been mentioned. Order point was calculated using lead time, review time, and average demand.

Safety stock is the quantity of an item that is maintained as a hedge or protection against stockouts resulting from above average or unexpected demand during the lead time. Since order point is based on average demand, it is raised to allow for the time when the average is less than the actual usage during lead time. This creates a buffer of inventory called safety stock. Adding safety stock has the effect of increasing the average inventory with an associated increase in maintenance cost. The additional inventory may be considered a good investment, up to some reasonable point, because stockouts may cause production delays or lost sales.

To better understand how safety stock might work, consider the inventory behavior of an item, first without safety stock (see Figure 7), and then with it (see Figure 8). In both cases lead time is 1 time unit. Note that with no safety stock, when actual usage is equal to average demand, the inventory is reduced to zero just as the new shipment comes in. Similarly, with safety stock, the level at which safety stock would be issued is reached when the shipment comes in.

If actual usage exceeded average demand, there would be a stockout in the first case; however, in the second case, safety stock would be used to fill orders.

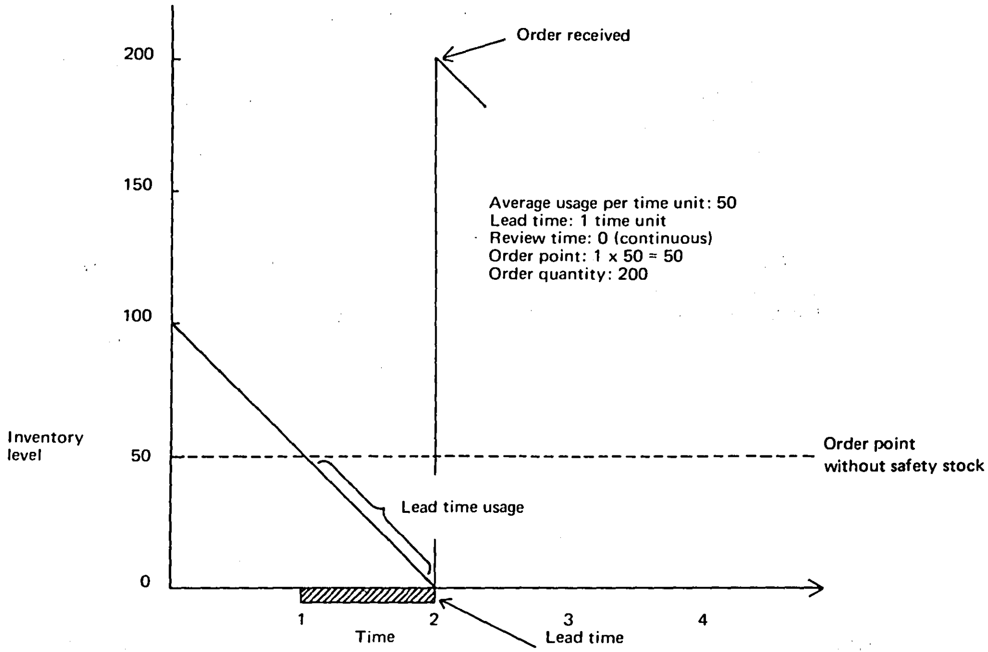


Figure 7. Inventory behavior without safety stock

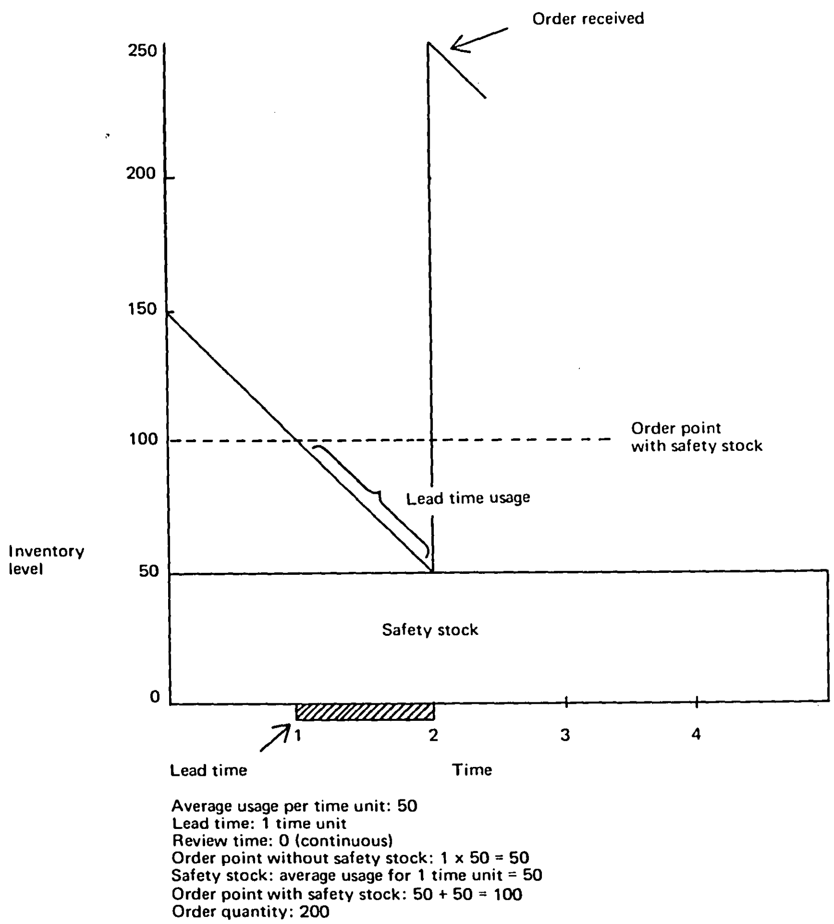


Figure 8. Inventory behavior with safety stock

The order point formula, expanded to include safety stock, used in System/3 Inventory and Requirements Planning is as follows:

Order Point = (Lead Time + Review Time) x Average Demand + Safety Stock

System/3 Inventory and Requirements Planning supplies several options for calculating safety stock. The user may select a method by properly initializing the order point calculation code in the item master record.

The methods are:

- A fixed quantity which the user assigns
- An amount of time which will be multiplied by the average demand per unit of time.

Note: In the ABC analysis example (Figure 3) a safety stock equal to two months' supply has been used; therefore, the safety stock equaled 1/6 of $3,000,000 or $500,000.

- A percentage of average demand expected during the lead time
- A percentage of order cycles for which the user does not want to have stockouts occur

The last method uses a technique that takes advantage of statistical concepts which permit the user to base safety stock upon a measure of projected (forecast) error.

The measure of error used is mean absolute deviation (MAD). Deviation is simply the difference between each period's actual demand and the average. Absolute indicates that all deviations are considered positive. Mean is another term for average of the absolute deviations. For example, if the average demand were 100, and the actual demands were 110, 90, 112, and 88 then the MAD would be 11 [(10+10+12+12)/4].

MAD can be used to determine how accurately the average demand has projected usage. This can be expressed in percentages based upon a normal distribution curve which is illustrated in Figure 9. The relationship between MAD and normal statistical standard deviation may be expressed as follows: standard deviation = 1.25 x MAD. A table of safety factors can be constructed based upon this relationship (see Figure 10). This provides an estimate of how well the average demand will project future usage. If, for example, the average demand of an item is 100 and the MAD is 10, the following probabilities exist:

Usage in next period not greater than	Probability (expressed as a percentage)
100	50 (average demand)
110	78.8 (average demand + 1 MAD)
120	94.5 (average demand + 2 MAD)
130	99.2 (average demand + 3 MAD)

Therefore, if the average demand is 100 and the mean absolute deviation is 10, the probability that the usage in the next period will not be greater than 100 is 50 percent. By adding 1 MAD to the average demand (10 + 100), the probability that the usage in the next period will not be greater than the average demand plus 1 MAD jumps to 78.8 percent, etc.

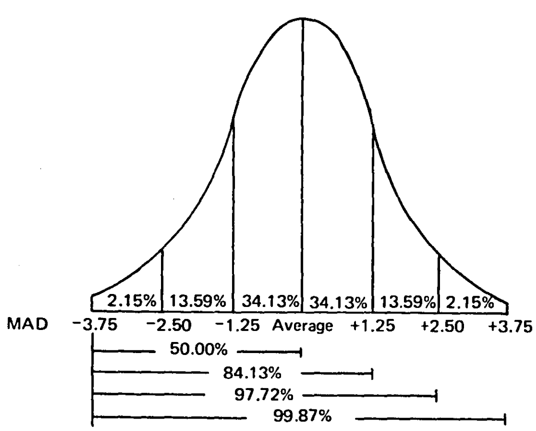


Figure 9. Area relationships under the normal curve - mean absolute deviation (MAD)

Safety Factor	Percent of Order Cycles with No Stockout
0.00	50.0
1.00	78.8
1.25	84.1
1.60	90.0
2.00	94.5
2.50	97.7
3.00	99.2
3.75	99.9

Figure 10. Safety factors for service levels using MAD (service based on frequency of stockout)

MAD can be used to calculate safety stock. It is usually multiplied by a safety factor which is related to the percentages stated above. For items where the MAD is small, safety stock will be small, and where the MAD is large, safety stock will be large. Assume two items (A and B) have an average demand of 100 units; however, the MAD for item A is 10 and the MAD for item B is 30. If the safety factor is 2.50, item A will have a safety stock of 25 units (2.50 x 10) while item B will have a safety stock of 75 units (2.50 x 30).

Up to this point, it was assumed that the lead time for an item and the length of time for average demand and MAD were the same. Normally, lead time is not the same as the projection interval (time period for average demand), and MAD must be adjusted to reflect the difference. This is done by using an adjustment factor selected from a table which is generated by the program product. From this point on it is assumed that MAD has been adjusted to conform to lead time.

Using this quantity (MAD or MAD multiplied by a factor) for safety stock we can be reasonably sure that no stockout will occur during the replenishment lead time for a specific percentage of the orders. Figure 10 illustrates several safety factors and the corresponding percentage of order cycles with no stockout.

Level of Service

The user must provide the percentage figure of order cycles without a stockout. If the user's input to the program indicates that 97.7% of the replenishment orders for that item must arrive before a stockout occurs, safety stock will be determined by multiplying MAD by the safety factor of 2.50. This percentage is referred to as service level, which in this case is based upon the frequency of stockouts.

This level of service is an estimate of how frequently stockouts will occur, and not an estimate of the quantity or size of unfilled orders. The expected frequency of stockout is related to the frequency of replenishment orders. That is, if 100 orders were placed for a particular item, it is probable that 98 of them would be received without a stockout occurring. If this item were ordered once a year, stockouts would occur in only two years out of 100. If the item were ordered weekly, a stockout would occur about once a year.

Service levels are usually set for each inventory item on the basis of the number of stockouts that can be tolerated when this measure of service is used. If, for example, service was specified as one stockout per year, an item that was reordered ten times per year would have a service percentage of 9/10 or 90%; while an item that was reordered five times per year would have a service percentage of 4/5 or 80%, meaning that a stockout would be tolerated during one of the five reorder cycles. The service percentage is then used with the table in Figure 9. A service percentage of 90, for example, would require 1.6 MADs as safety stock.

With this measure of service it is possible to:

1. Establish the service level policy in terms of the number of stockouts per year that can be tolerated

2. Divide the annual usage by the order quantity to determine the number of reorder cycles

3. Calculate the percentage of reorder cycles that would not have stockouts and use this percentage to determine the proper safety factor

When using this measure of service, the program accepts the service level stated as a percentage.

Other Features

The order point program also furnishes an index value useful for estimating when an item should reach order point. The program subtracts the order point quantity from the available quantity. If the difference is negative or zero, the item has reached the order point, and the index is set to zero. If the difference is positive, it is divided by average demand to provide an estimate of how many time periods of supply exist over the order point. This routine is especially applicable to fixed review periods normally encountered in warehouse replenishment. It could also be used to determine what to order for a family of items. That is, for groups of items, it may be more economical to order several items within the group at one time because of vendor restrictions or because a high setup cost is associated with a particular machine that with slight modifications can be utilized for other items in the family.

In this way, the large setup cost can be distributed to many parts rather than to one or two. The user can process these items separately to obtain a report to aid in formulating ordering judgments. For example, assume there are 30 items in a particular family, and four of these have reached order point. If this number of orders is not economical, additional items can be selected using the index value. Items that have a value between 0.1 and 0.9 should reach order point during the next time interval, while those with values between 1.0 and 1.9 have an additional time period of supply. This progresses to the maximum value of 99.9.

The analysis for implementation feature of this program permits the user to analyze what might happen when different safety stock formulas or level of service values are used. This is accomplished by contrasting certain aspects of the existing technique to the aspects of the proposed technique.

If a user is currently calculating safety stock on the basis of a two months' supply, and he would like to use one of the statistical methods, it would be advantageous to know the value of the safety stock for both methods. The program calculates the new safety stock and multiplies it and the old safety stock by unit cost. The safety stock value resulting from each calculation can then be compared and evaluated.

This feature can also be used in a simulation mode to provide alternate plans and values so that management can select the plan to implement. If a user would like to implement safety stock on the basis of level of service, a logical question would be: "How much will this cost?" The answer can be provided by processing the order point items (or a selected sample) several times. Each time, a different percentage of service is used. The value of the safety stock is accumulated and recorded for the different percentages which can be contrasted to the present values. When the program is used in this way, the file is not changed.

An output report is produced which indicates the results of these calculations. An example of the order point report is shown in Appendix C. A variance code indicates that the new order point has increased or decreased by a specific percentage. The order point program generates the order action work file on the basis of the status of the inventory items processed during the execution of the program. This file may contain order recommendation, order follow-up, and/or order notice records. If the new order point is greater than the available stock, order action is indicated by creating an order recommendation record, which provides information for reentry into the system when the order is placed. The program checks the order point recommendation code (MOPRD) field in the item master record. If the code indicates that an order recommendation was previously created, an option in the parameter record causes an order follow-up record to be created for the item.

There is also an option which provides for creating an order notice record. This is to signal the possible need for expediting an existing order. If the on-hand stock has decreased below the safety stock level or some percentage thereof, and if an order already exists that precludes the need for further ordering, the order notice record under the option would be created.

<u>Summary</u> - <u>Order Point Program</u>

When a replenishment order is issued, item usage during the interval before receipt of the order is uncertain. Order point is set to allow for this uncertainty. If the order point is based on average demand alone, stockouts can be anticipated during about half of the replenishment cycles. Obtaining better service requires raising the order point by adding safety stock. Methods for arriving at the safety stock include: (1) specifying a quantity, (2) specifying an amount of time to be multiplied by average demand, (3) specifying a percentage factor that is applied to lead time and multiplied by average demand, and (4) utilizing statistical concepts that make it possible to find a safety factor which will yield a specified level of service. The measure of service is frequency of stockout without regard to size or number of unfilled orders (order service). The safety factor is taken directly from the normal curve table using service percentage or a calculated service percentage of reorder cycles in which no stockout is desired.

The program requires the user to identify the items that are classified as order point items, as well as the method to be used for safety stock calculation. This may be accomplished by placing codes on the item master record using the inventory analysis classification or update programs or by providing them in the parameter record for this program.

The user must furnish the factors (that is, level of service, safety stock time, percentage of lead time, and lead time) that are used in the program. MAD and average demand are calculated in the projection phase and are stored on the item master record.

The order point program is normally run at the end of each time period for which average usage is calculated. The inputs are a parameter record and item master file. A general system chart is shown in Figure 11.

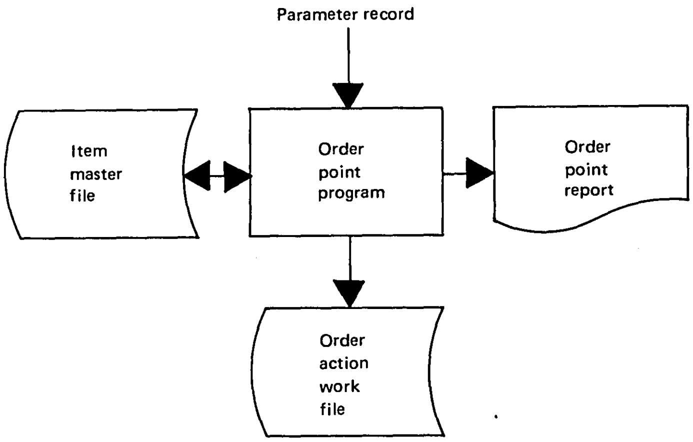


Figure 11. General system chart - order point program

The item master file is updated by this program to reflect the new order points which become the basis for order action in subsequent programs of the execution phase.

ORDER QUANTITY PROGRAM

Determining how many of an item to order is one of the most significant aspects of inventory control management. The quantities in which items are manufactured or purchased have a direct relationship to the average level of inventory.

The formula for determining average inventory level where usage is relatively constant is:

$$\text{Average Inventory} = \frac{\text{Order Quantity}}{2} + \text{Safety Stock}$$

Judgments regarding the size of the order quantity influence the number of dollars required for this investment. A company can realize substantial savings if significant reductions can be made to the inventory level. These reductions must not disrupt the operation of the plant nor should they be offset by a corresponding increase in other costs.

Figure 12 illustrates the relationship between inventory level and order quantity. The average inventory level for the item shown can be reduced from 600 units to 300 units by decreasing the order quantity from 900 units to 300 units. The item would have to be ordered more often, thus increasing the number of orders that must be processed and the number of times a production item must be set up in the shop.

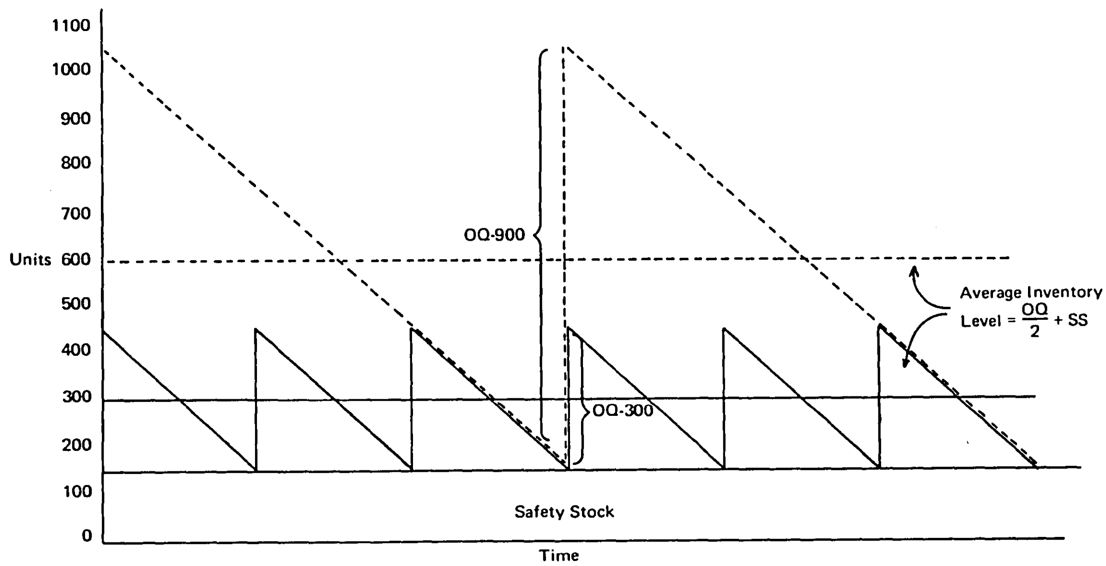


Figure 12. Order quantity and inventory level

<u>Standard</u> <u>Economic</u> <u>Order</u> <u>Quantity</u> (<u>EOQ</u>)

The costs that go up as the order quantity is decreased are those associated with the replenishment order. These include setup cost, order or paperwork cost, and some portion of the cost of expediting, scheduling, dispatching, etc. The costs that go down when the order quantity is decreased are those associated with the higher level of inventory. These are usually described as inventory carrying costs and include the value of money tied up, storage cost, obsolescence, taxes, etc.

There should be an economic balance between the costs that increase and those that decrease as the order quantity varies. This determination is the principal task of economic order quantity calculations.

The standard economic order quantity (EOQ) formula can be used to balance these costs and calculate an order quantity for each item. Figure 13 graphically illustrates the concept of economic order quantitity. The point at which the sum of the two lower curves reaches a minimum, in this case the point at which they cross, is the most economic order quantity. Normally, the total cost curve is flat in the area of the minimum. This fact allows some flexibility in rounding of order quantities to more convenient numbers.

The standard EOQ formula used by the program is:

$$Q = \sqrt{\frac{2AS}{I}}$$

where:

Q = Order quantity
A = Cost of setup and order writing in dollars
S = Annual usage
I = Cost of holding one unit in stock for one year
(unit cost x carrying rate)

The formula is based upon the following assumptions:

1. The most significant costs in the purchasing decision are acquisition costs and maintenance costs.

2. The cost of an order is constant regardless of the number of orders.

3. The per unit cost of carrying an additional unit in inventory is constant regardless of the number of units in inventory.

4. The whole order quantity arrives at one time (no partial shipments).

5. Demand is known and constant.

6. The incremental cost of an additional unit in a single purchase is constant--that is, there is no program automatically handling quantity discounts.

7. The purchasing decisions made for one item have no effect on the purchasing decisions made for other items.

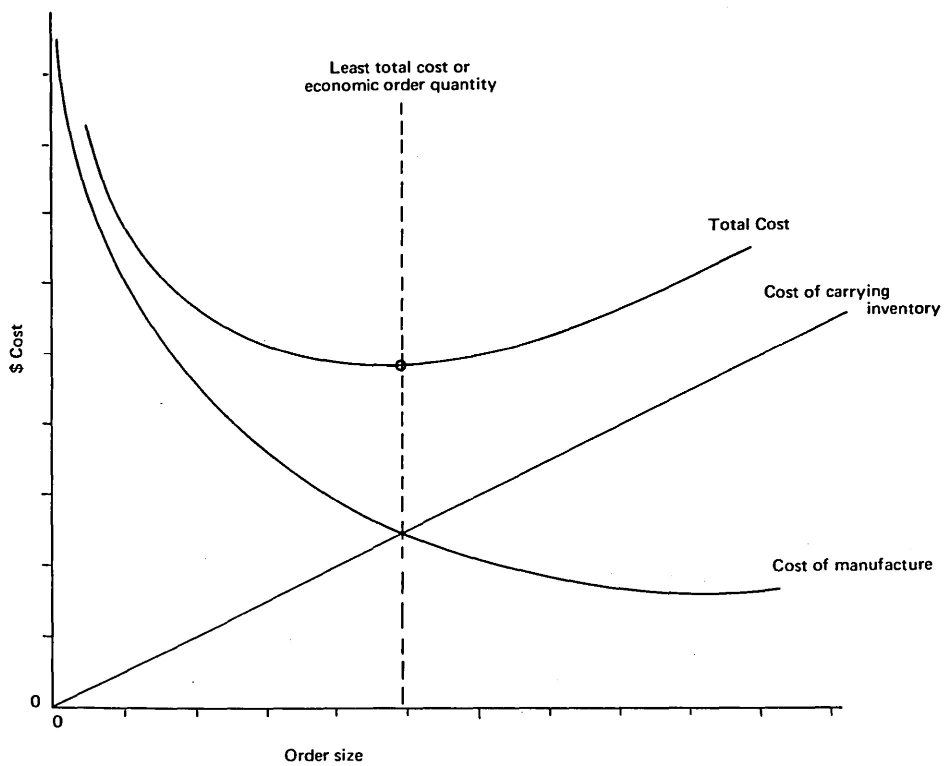


Figure 13. Economic order quantity

The calculation is relatively easy and the results can be obtained quickly. The factors used in the formula may be more difficult to ascertain. However, these factors are real--that is, there is a cost of carrying inventory and a cost associated with processing an order and each user must determine these values. They should be as realistic as possible in order to derive the most economical order quantities.

In some cases there may be other conditions that influence the order quantity. For example, the physical size of an item relative to storage space, or the amount of time required on a specific machine may restrict the number of items to be produced at one time. Storage and/or packing requirements or the material from which the item is produced may require that the order quantity be made in specific increments.

The program provides the facility for specifying minimum, maximum, and multiple quantities for each item. On an optional basis, the order quantity is checked to ensure that it is within the range of minimum and maximum quantity and that it has been rounded to the nearest multiple.

Time Periods Of Supply

The program provides another method for calculating order quantity on the basis of average usage. This enables the user to specify an amount of time to be used for determining order quantity (for example, three months' supply). The user supplies in a table the number of time periods to be used for one or more items and places a corresponding code on the inventory record. The program uses this information and the latest average to calculate order quantity. The number of time periods can be different for each category code. Note that this type of ordering policy was used in the ABC analysis example discussed in the section entitled "Inventory Analysis".

The economics of this technique depend upon the user's judgment regarding the cost of the item, its related carrying expense, and the setup cost. Other methods of calculation based upon future requirements are discussed later.

If a manufacturing company has not used some cost balancing formula for determining order quantities, many benefits can be derived by using this program. These benefits will probably be realized over a period of time rather than as a result of one run of the program. It is very unlikely that a company would change the order quantities from the present values to the newly computed values in a short period.

Analysis For Implementation

Many questions must be resolved before implementing economic order quantity calculations: What is the value of the savings that can be attained? Where are we now, and how can we realize these savings? What will happen to the number of orders that have to be issued? Are there items or groups of items that will provide substantial savings? Can we analyze what might happen before changing the quantities? If so, what action can be taken to reduce or eliminate undesirable aspects (for example, excessive setup requirements for a particular group of machines)?

The order quantity program provides an order quantity analysis report to support the analysis for implementation feature to help answer these questions.

Basically, this report enables the user to experiment with the various aspects of economic order quantity calculations for all, or a selected portion, of the inventory file. The program provides for contrasting the present order quantities with the newly calculated order quantities. For example, assume a user has performed an ABC analysis of the inventory and has divided it into several groups. Codes have been placed on the inventory records to identify the group to which each item belongs. The user would like to analyze the high-value items represented by a particular code. He would like to know the difference in inventory level for these items if the order quantities were changed to the order quantities calculated by the EOQ formula. In addition, it would be desirable to highlight the items where the difference is significant. Using a parameter record that is read by the program, the user indicates this request. The program locates each inventory record and calculates the order quantity on the basis of the input parameters for cost of carrying inventory and order cost. The item information required in the formula is stored on each inventory record. The dollar values of the old and the new inventory levels (as determined by the order quantity) are computed and printed for each item and summarized by order quantity category code, and in total, for the entire run. Each item is checked to determine whether the difference in inventory level is such that the item should be highlighted on the output report. The totals would be useful to evaluate the effect that the new order quantities would have on inventory value.

During the same computer run, it is possible to determine the number of orders and the total order cost per year for each item and to accumulate these figures for both order quantities. This information is useful in determining the effect the order quantities have on setup and order or paperwork costs.

This kind of analysis is very useful before changing order quantities. The program provides for variations in processing inventory records and performing calculations. The program can process all items in the inventory file or a portion of the file. A code in the item master record can be used to select the items to be processed.

The program has provision for using different ordering costs and carrying rates during the same calculation. The selection of costs and rates is based upon an order quantity category code stored on the item record. For example, a given category code causes an ordering cost and carrying rate to be taken from a table included in the program; a different category code causes a different set of ordering cost and carrying rate values to be used, etc. In this way, the user can evaluate different rates and ordering costs for items without storing this data on the item master record. This also makes it very easy to change these factors for experimentation purposes or for evolving to the desired value of these factors. The setup cost, unit cost, and usage information for each item are stored on the item master record.

In addition to the foregoing calculations, the carrying cost implicit for the present order quantities is calculated and printed as an optional feature. This can be used to identify items the user should examine closely to ascertain why the present order quantity is not consistent with the average cost of carrying inventory.

Fixed Quantity

The user may also enter a specific, fixed quantity which will always be used as the order quantity. This will be useful for items ordered in fixed lots such as barrels or pallets.

User Method

Provision is also made to allow the user to insert into the program his own method of computing order quantity.

Summary - Order Quantity Program

The order quantity program has a provision for calculating order quantities four ways:

1. Standard or classical EOQ formula
2. Time periods of supply
3. Fixed quantity
4. User method

The order quantity category code enables the user to specify many combinations of order cost and carrying rate without placing this information on the item master file. The carrying rate field is used for periods of supply when this type of calculation is specified. The order quantity category code is advantageous for making changes to these values to gradually bring them in line with the general ordering policy.

The frequency of running the order quantity programs depends upon each user's requirements. Normally, the items considered as having a fixed order quantity would be processed once or twice a year. If the quantities are not considered economical, the program and its analysis for implementation feature can be used again and again over a period to help ensure an orderly transition to the desired quantities.

The analysis for implementation feature used with the EOQ formula and time periods of supply techniques encourages the user to simulate and to evaluate changes before implementing them. The evaluation provides a logical plan for obtaining the economical benefits of order quantity calculations without disrupting the day-to-day operation of the plant.

The program can accommodate a variety of options regarding the items to be processed. The parameter record is used to indicate the options elected by the user. Refer to Figure 14 for the general system chart for the order quantity program.

Output consists of the order quantity report which includes the analysis for implementation summary. The summary permits the user to evaluate the effect of the program options that he has selected. The order quantity report is illustrated in Appendix C.

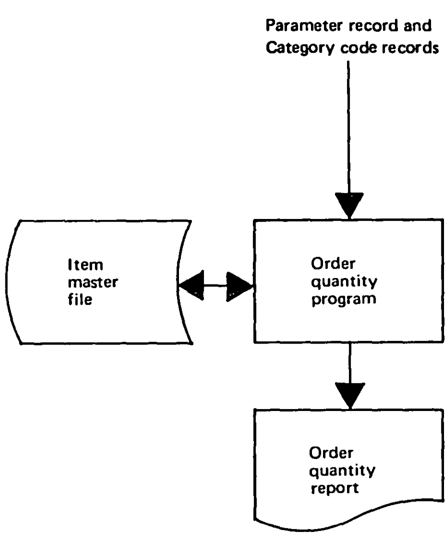


Figure 14. General system chart - order quantity program

INVENTORY CONTROL PHASE SUMMARY OUTLINE

Input

Parameter records
Item master file
Code definition records
Update records
Category code records
Analysis work file (sorted)

Programs

Inventory analysis - usage extension
Inventory analysis - report
Inventory analysis - classification
Inventory analysis - update
Order point
Order quantity

Item Master File (Fields Used)

Record activity code
Item number
Allocated quantity
Alpha factor
First average
Mean absolute deviation
Model type code
Second average
Safety factor
Lead time code
Lead time--manufacturing
Lead time--purchasing
On-hand total quantity
Order point calculation code
Carrying rate
Minimum
Maximum
Multiple
Order policy code
Order point
Order quantity
Order point recommendation code
Review time
Safety stock
Order quantity category code
Item description
Total on-order production quantity
Total on-order purchase quantity
Number of periods of usage
Usage quantity
Record identification code
Item type
Setup cost
Unit cost
Unit price
Inventory value classification code

Output

Inventory analysis report
Updated item master file
Order point report
Order quantity report

Order action work file (recommendations, notices, follow-up)
Analysis work file
Inventory analysis classification report
Audit list

PROJECTION PHASE

The projection phase consists of the update and project program.

A question often asked in a manufacturing organization is, "How many of what items must we manufacture?" If too few of a given item are produced, orders may be lost. If too many are made, money may be wasted. The same consequences result if a desired item is not produced and vice versa. A manufacturing plan based on expected product demand must be established to resolve this question. In addition, a technique for estimating demand is essential for determining usage through lead time for order point items.

There are two basic methods of anticipating demand: prediction and projection. Prediction is an educated guess and involves no formalized use of numerical data. Projection, or forecasting, implies some manipulation of numerical data.

The role of projection is to analyze historical data about the demand process and project for a desired planning period (for example, lead time of an item, a season or a year).

Output of the projection program can be combined with other information available to the planner such as economic trends, competition, market trends, etc., to yield a solid foundation for the plan.

While a computer projection by itself may not be completely sufficient for planning purposes, the man-machine cooperation achieved by such an approach takes advantage of the capabilities of both the planner and the computer.

UPDATE AND PROJECT PROGRAM

The update and project program is designed to assist in the planning function. It also calculates the latest average and a measure (MAD) of how accurate the average is expected to be relative to estimating future demand, the latter being useful for safety stock and order point computations.

The update and project program uses a technique known as exponential smoothing. Stated simply, smoothing is a technique comparable to finding an average of historical data and, as the data for each new period becomes available, developing a new average of the old and new demand data. The old average and the data for the new period are weighted in such a manner as to give a controllable degree of importance to the old average, depending on the desires of the user. The formal expression used is as follows: new average = old average + alpha factor (new demand - old average), where the alpha factor is the weight assigned to the new data. The alpha factor determines the relative weight to be given to old and new data.

The conventional moving average technique requires that several periods of the most recent data should always be maintained on the file. The smoothing approach requires only that the old average be carried forward each period. The term exponential smoothing is derived from the fact that the new piece of data, when averaged with the old average, has less effect on the overall calculation as time progresses. If the effect that a piece of data has on the new average over a period of time was plotted, it would follow an exponential curve. This effect is illustrated in Figure 15 for an alpha factor of .1. The latest demand makes up 10% of the new average. One period later, its contribution is reduced to 9%, two periods later to 8.1%, and so on, until 20 periods later, when the contribution of the data is about 1%.

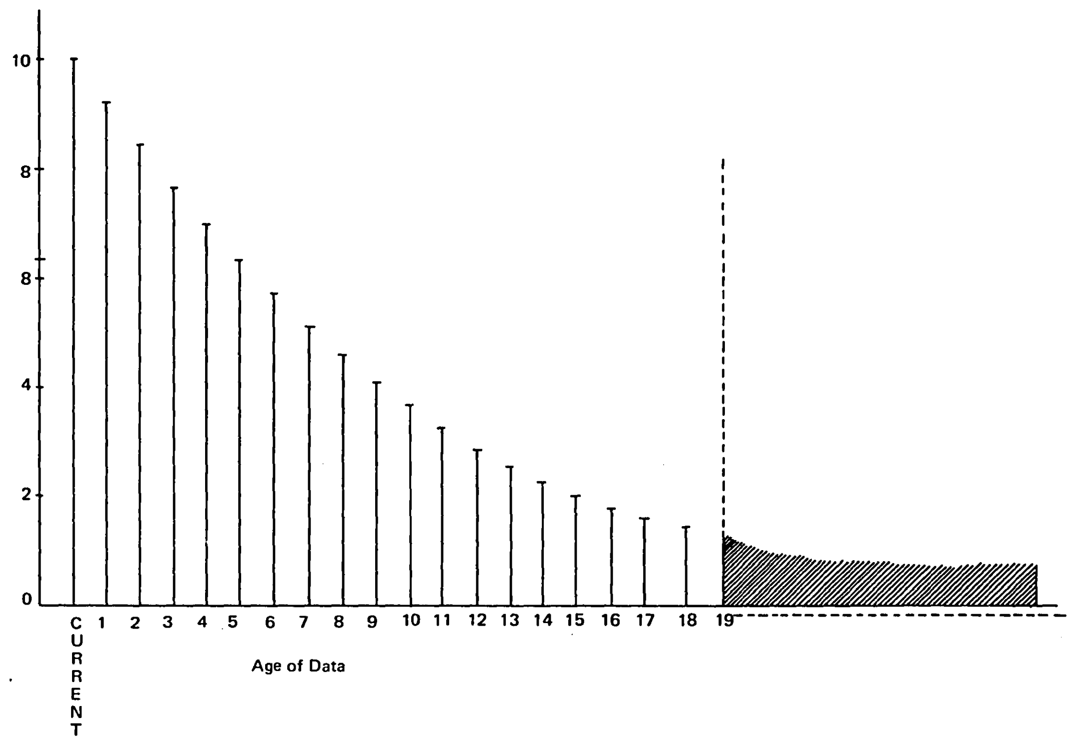


Figure 15. Weighting of data with smoothing constant = 0.1

The exponential smoothing technique, with variations, can be used to calculate the averages for several demand patterns. The projection programs provide two demand patterns or models:

1. Horizontal (constant)
2. Trend

Horizontal Model

The horizontal method is a representation of demand as centered around an average value, with variations attributed only to random causes and which cannot be expected to occur in any consistent pattern. It is also called a constant or point model. The mathematical representation is a single number (first average) that may be determined by single exponential smoothing.

Trend Model

The trend method is a representation of demand that consistently increases or decreases with the passage of time. It is also called a line, ramp, or slope model. It is mathematically represented by two numbers (first average and second average) which are averages for different points in time, so that the amount of change per time unit may be calculated and used to extend the line to the present or future. The projecting technique is double exponential smoothing which is used to calculate and store the first and second averages of trend models.

Use Of Models

Each model requires certain minimum information. The fields are listed in Figure 16 with an indication as to which are required for each model. These values may be initially provided by the user or calculated by the program based on historical data. They are kept up to date by the update and project program, which uses the latest demand, in conjunction with the existing values, to calculate the new values for these fields. The updated values can be used at any time to estimate future demand which reflects the latest information.

Fields	Horizontal	Trend
Model type	H	T
First average	X	X
Second average		X
Mean absolute deviation	X	X
Sum of the deviations	X	X
Alpha	X	X

Figure 16. Data fields required by model

The mean absolute deviation is included for each model. It is computed by the update and project program and is used to determine the accuracy of the existing values (model type, first average, etc.) relative to the new demand that is made available each time period. Items can be highlighted for analysis outside the system when the new demand does not conform to existing patterns and values. The mean absolute deviation is the average of the differences between expected demand and actual demand for each time period. The difference is always considered positive. The sum of the deviations is the algebraic sum of the differences. The ratio of the numbers (sum of deviations/MAD) is checked against an upper and a lower limit to determine whether the existing values are consistent with most recent demands. This ratio is usually referred to as the tracking signal since it indicates how well the actual demand has been projected.

The update and project program accepts the most recent demand and updates the item master record. The program also projects future demand on the basis of the information stored in the file.

The calculations for updating fields using the update and project program depend upon the type of model. Generally, the incoming demand is used to update the averages, MAD, and sum of the deviations. For example, a horizontal item requires changes to the following fields: first average, MAD, and sum of the deviations. MAD and first average use the standard smoothing formula, while the sum of the deviations is an algebraic accumulation. The symbol (α) is used to represent the alpha factor in the smoothing formula.

If the current demand were 330 and the first average were 300, the new first average would be 303 (alpha = .1).

new first average = old first average + α (demand - old first average)
= 300 + .1 (330-300)
= 303

Using the same formula for MAD, the new value would be 21 if MAD were 20 before this period.

new MAD = old MAD + α (difference - old MAD)
= 20 + .1(30-20)
= 21

The difference between demand and the first average (330-300=30) is 30, which is exponentially smoothed with the existing value for the sum of the deviations.

The inventory record would be updated to reflect these changes. If the item model type were trend other fields would also be updated.

The item information is ready for use in projection. The user can specify the number of time periods for which the projection is to be performed. In the case of a horizontal item the projection for the next time periods is the first average stored on the record.

For trend items the value of trend is computed for the time interval. This is added to each succeeding time period's projection. Therefore, the projection for the first time period is the average demand plus 1 multiplied by trend, while the projection for the second period is the average plus 2 multiplied by trend.

The average demand for the current time period is calculated on the basis of the first and second averages (average demand = 2 x first average - second average).

Output from the update and project program consists of a projection report and updated item master records.

The update and project program also has the capability to calculate the new averages and project demand for all or specific items stored in the file. This can be done in various combinations on the basis of parameters made available to the program. For example, the user may wish to compute the new averages for all items, but project for only a portion of the file (for example, end items only).

At another time, the user may wish to project all end items (or perhaps only the high-value items as determined by a code in the item master record) for one year. It may be desirable to do this independently of changing the averages, as the run is being made at other than the end of a time period. These combinations are provided so that the user has a great deal of flexibility with regard to the capabilities of this program.

<u>Summary - Update and Project Program</u>

The update and project program performs the necessary functions for estimating future demand (see Figure 17). Appendix A contains the specific formulas used in this program.

The update and project program provides the information regarding demand that is used in the order point program. The update and project program has the flexibility of processing all records in the item master file, or a portion thereof, in addition to highlighting unusual conditions for examination outside the system. The projection report, which is illustrated in Appendix C, is produced by this program.

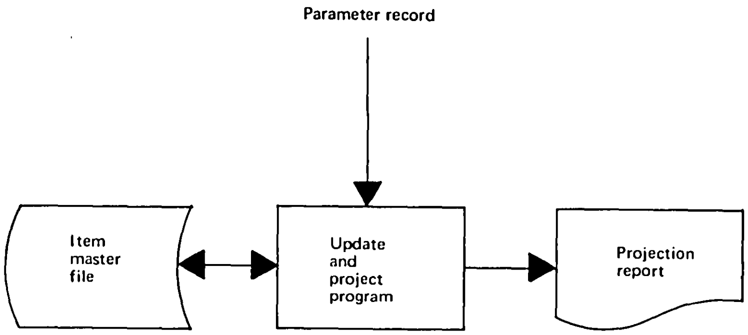


Figure 17. General system chart - projection phase

PROJECTION PHASE SUMMARY OUTLINE

Input

Parameter record
Item master file

Program

Update and project

Item Master File (Fields Used)

Record activity code
Item number
Current sum of demand
Alpha factor
First average
Mean absolute deviation
Model type code
Second average
Sum of deviations
Trend
Order policy code
Order quantity category code
Projection code
Number of periods of usage
Usage quantity
Tracking signal sequential count
Record identification code
Item type
Inventory value classification code
Gross requirements fields

Output

Projection report
Updated item master file

REQUIREMENTS PLANNING PHASE

The third phase of System/3 Inventory and Requirements Planning consists of four programs: (1) initialization, (2) requirements generation, (3) requirements report, and (4) exception report. Refer to Figure 18 for the system flow of the requirements. The initialization and requirements generation programs must always both be executed in that order for any type of run. The requirements report program can be optionally run following execution of the requirements generation program. The exception report program should be run to list the exceptions.

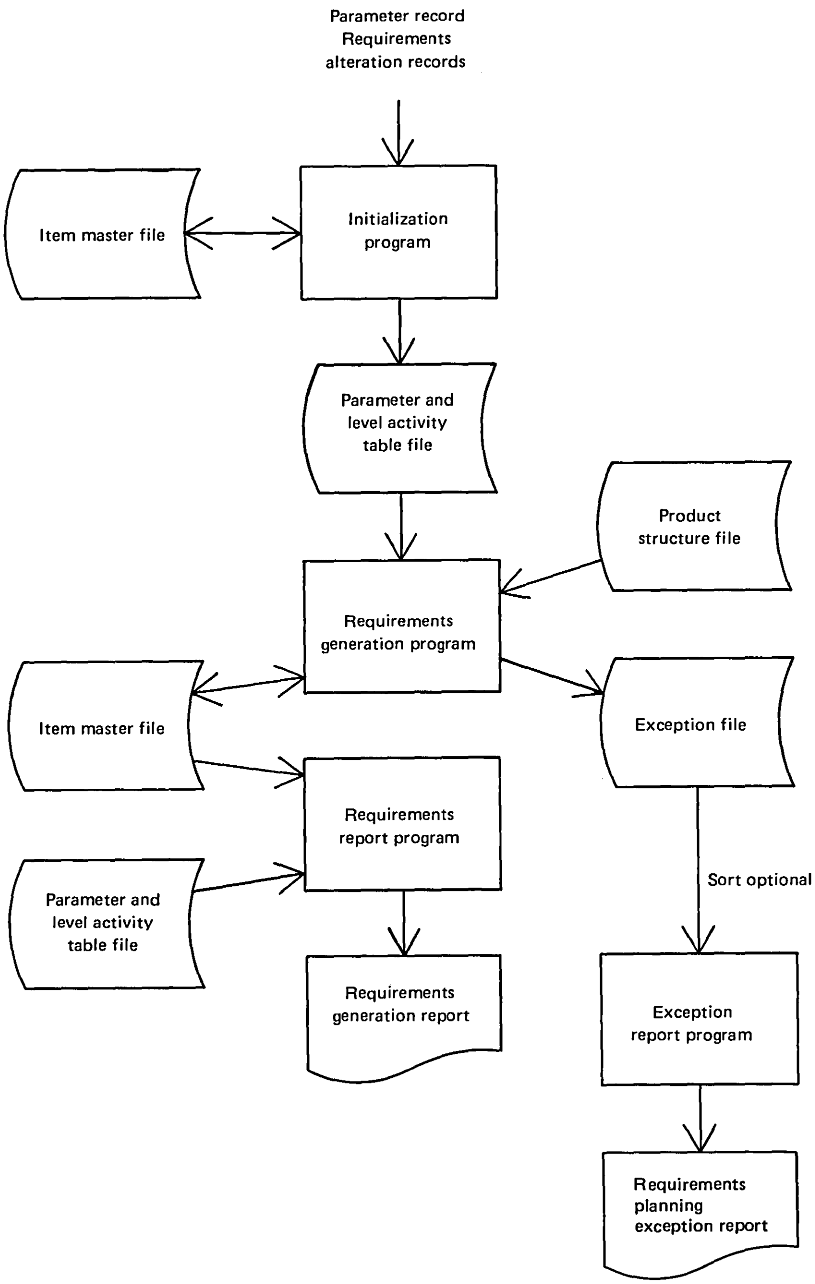


Figure 18. General system chart - requirements planning phase

INITIALIZATION PROGRAM

The major functions of the initialization program are to read and edit the parameter record, to establish the type of run to be performed, process input, and establish the initial activity chain. The activity chain provides direct addressing for those items that are to be processed during the run. There are two types of runs, normal and requirements alteration. In a normal run, a complete generation of requirements is performed for all items and through each level of components. A requirements alteration run performs a generation of requirements for a specific item or items. It is used when the gross requirements for an item or items must be modified in a specified time period.

Input for either type of run consists of gross requirements. Requirement alteration record input is required for a requirements alteration run while disk input is used for a normal run. The disk input is the gross requirements stored in the item master record for each item. The format for each gross requirement for either type of run is date and quantity with the date being a three-digit shop date. A shop date is a day within a dating technique which eliminates non-work days and numbers the remaining days from 001 to 999. One record of disk input contains all of the gross requirements for one item while there will usually be more than one requirement alteration record for an item. Disk input is assumed to be edited because the majority of this data is generated by programs. The remaining data should have been edited when the files were initially created. Requirement alteration input is edited by System/3 Inventory and Requirements Planning.

To perform requirements planning, gross requirements and planned orders must be stored. Open orders need not be stored, but this means that the calculation of net requirements (see "Requirements Generation Program" below) can consider only on-hand inventory. Planned orders and open orders, if stored, must be stored in a date and quantity format just as are gross requirements. The number of date/quantity fields for each type of data is user specified.

Program Processing

The initialization program examines the run parameter record and tests for invalid parameter values and invalid parameter combinations. The run is terminated if an invalid condition exists. The parameter record specifies whether a particular run is a normal run (complete generation) or a requirement alteration.

For a normal run, the initialization program sequentially reads the item master file. The planned order fields in each item master record are set to zero because new planned orders will be created by the requirements generation program. If the item master record contains gross requirements, the item is placed in the level activity table chain so that it will be processed by the requirements generation program. The item master record is then written back on the item master file.

For a requirements alteration run, the item master record is read and matched to each requirement alteration record. The planned order fields are not changed. The gross requirement fields in the item master record are all replaced with the gross requirement quantities in the requirement alteration records because requirements alteration only involves making a revision to the gross requirements of specific items. The item master record is then written back on the item master file.

REQUIREMENTS GENERATION PROGRAM

The requirements generation program reads the parameter record to determine if this is to be a normal run or a requirements alteration run. The processing for each run differs. The normal run is discussed first.

Normal Run

The requirements generation program processes one level of data at a time, using the item master record relative record number in the level activity table and the relative record number of the next item master record in the activity chain (field I$NMRA in the item master record) as a means to retrieve only those items that are active at the specific level. The standard procedure, after retrieving the item master record to obtain the gross requirements, consists of calculating net requirements, storing planned orders, retrieving the item's components, and extending and posting the offset planned orders to an item's components.

The purpose of calculating net requirements is to reduce the gross requirements by any available on-hand inventory and open orders, thereby determining the number of items for which orders must be planned for manufacture and/or purchase.

CALCULATE NET REQUIREMENTS: The calculate net requirements function first subtracts safety stock from the total on-hand inventory. If the on-hand inventory is greater than the safety stock, the difference becomes available-for-net. This available-for-net is then reduced by the total allocated quantity. The remaining available-for-net is further reduced by gross requirements until the available-for-net is reduced to zero. All remaining gross requirements are then temporarily increased by the shrinkage factor. The open orders are next reviewed and added to the available-for-net. Gross requirements are subtracted from the available-for-net and, when the available-for-net has been reduced to zero, any remaining gross requirements are added to net requirements for that period.

There are several conditions that may occur and it is important that the user understand how these conditions are treated in the program.

Should the safety stock quantity be greater than the on-hand inventory, the difference is considered as a gross requirement and is increased by the item's shrinkage factor. If the allocated quantity is greater than the on-hand inventory less safety stock, the difference is placed in the first gross requirement time period and all gross requirements are temporarily increased by the shrinkage factor before any netting against open orders. An exception notice is generated showing that the allocated quantity exceeded the available for net and the difference was placed in the first gross requirement time period.

When netting against open orders, a net requirement may result within a scheduled open order. When this occurs, System/3 Inventory and Requirements Planning nets this requirement against any open order that is scheduled in the future. The reason for this practice is that it is more practical to expedite a portion or all of the open order rather than plan a new order to cover the net requirement.

The above situation will occur under either of the following conditions.

1. An open order is not of sufficient quantity to cover the gross requirements for a time period and an open order is scheduled in some future time period.

2. A net requirement is developed and an open order is scheduled in a future time period.

In both of the above situations, two exception notices are issued to provide the necessary information for expediting the open order: an exception notice containing the date and quantity of the requirement that has been netted against a future open order, and an exception notice containing the date and quantity of the open order.

The following illustrates this condition:

Time Period	1	2	3	4	5	6	7
Gross	150	50	75	150	50	75	100
Open orders	198		225				
Net	0	2	0	0	50	75	100
Planned orders		X					

In the illustration, a net requirement of 2 exists in period 2 because the first open order is not of sufficient quantity to cover the first two periods of requirements. If left undetected, the net requirement in period 2 would cause a planned order to be developed to cover this requirement. It is normally not desirable to plan a new order to cover a net requirement that precedes an existing open order.

The following illustrates how System/3 Inventory and Requirements Planning solves this condition:

Time Period	1	2	3	4	5	6	7
Gross	150	50	75	150	50	75	100
Open orders	198		225				
Net				2	50	75	100
Planned orders				X			

By netting period 2's net requirement against the future open order that is due in period 3, a net requirement of 2 is created in period 4. This allows the planned order function to correctly apply economic lot sizing practices. In addition, by issuing the exception notices, the proper information is available to expedite the open order in period 3.

During the netting procedure, the open orders are reviewed for several conditions that create exception notices (see the section entitled "Exception Report Program" for a complete description).

SHRINKAGE FACTOR OPTION: If elected, this option adjusts requirements upward to reflect scrap loss of an item during production. The user-specified shrinkage factor is a percentage that is located in the item master record for each item. It is applied to the remaining gross requirements after they have been reduced by the on-hand quantity.

PLANNING ORDERS: The result of combining requirements into planned orders can affect the level of inventory. Since inventories represent a sizable portion of a company's investment, the application of a proper order policy to an item is extremely important.

The following planned orders policies are available in the program:

- Fixed quantity
- Discrete order
- Part period balancing

Fixed quantity uses a technique by which all requirements for a given period are combined into one planned order. The discrete order policy, on the other hand, creates a planned order for each period that has a requirement. Part period balancing, on the basis of order cost and inventory carrying cost, determines how future requirements should be grouped for orders. The modifiers to order policies, minimum, maximum, and multiple factors, are applied against the planned order quantity for each item.

OFFSETTING REQUIREMENTS: The purpose of offsetting is to use the gross requirement's due date and the amount of purchasing or manufacturing lead time associated with the item to determine the planned order start date.

Each item master record contains the offset time. The offset time is specified by the user. For a purchased item, the offset is the total purchase lead time, starting with the procurement cycle, including vendor lead time up to the point the item is received in stock. For a manufactured item, the offset time is expressed as a total lead time. Since fixed lead times are used, three fields are required in the item master record: one for total purchased lead time, one for total manufactured lead time, and a lead time code field to indicate whether purchased or manufactured lead time is to be used.

If, in the process of offsetting by lead time, a requirement falls into a past period (one prior to the first date of the planning horizon), that requirement is placed in the first time period and an exception notice is printed indicating the number of days into the past the requirement was offset.

Care should be exercised in establishing the lead times because of the effect of offsetting as requirements are generated throughout the levels of the product structure. Excessive lead time offset generates requirements early, thereby increasing inventory carrying costs. Fixed lead times are expressed in number of shop days; offsetting starts from the first day of a time period.

STORING PLANNED ORDERS: This routine stores the planned orders in the item master record.

In a requirements alteration run, prior to storing the planned orders, the existing planned orders in the item master are moved from the record area. They are used by the extend and post component gross requirements processing to carry the effect of the gross requirements alteration to the components.

If the user has elected to offset the planned orders, the planned orders stored are offset, with the date in the record being the start date for the purchasing or manufacturing cycle. If offset is not elected, the stored planned orders are not offset, and the date on the record refers to the date required. However, in this situation, the requirements to be extended and posted to the components are not offset, and the lead time through the product structure is not reflected.

RETRIEVAL OF ITEM'S COMPONENTS: The item master being processed is checked to determine whether it is a purchased item, a piece part, or an assembly. If the item is not an assembly, it is not exploded. If it is an assembly, the item is known to have subassemblies and/or parts, and its product structure record is retrieved. Using the relative record number of the component item master which is contained in the product structure record, the item's component item master record is retrieved, and a check is made to determine whether the item is an inventory-controlled order point item. This type of item is not processed by the requirements planning program because its ordering practice is controlled and an order is triggered for an item when physical depletion of stock reaches an order point status.

If the component is not an order point item, its use in the product structure record is extended by the parent item's demand through the extend and post component gross requirements routine.

EXTEND AND POST COMPONENT GROSS REQUIREMENTS: This routine moves the parent item's requirements to the component gross requirement work area, where each requirement is multiplied by the quantity obtained from the product structure record. The computed value is always rounded up to the next whole unit (decimal point is dropped). The result is added to the component gross requirements. The final results are moved to the component record area.

END OF PROCESSING ONE ITEM: The processing of one item is now completed, and the program processes the next item in the level activity table. This is repeated until all items have been processed for one level in the level table. When the level is completed, the next lower level is processed.

Requirements Alteration Run

The requirements generation program processes an alteration to gross requirements by reading the level activity table and calculating net requirements, planning orders, and offsetting requirements as was done in the normal run for each item. At this point the processing differs from the normal run. The combination of the planned orders currently stored (before the alteration) and the new planned orders (created from replanning) carries the effect of the alteration to the components of the original item. This is accomplished by (1) extending the stored planned orders by the usage in the product structure record and subtracting the result from the component's gross requirements, and (2) extending the new planned orders by the product structure usage and adding the results to the component's gross requirements. In this way, the component's gross requirements are adjusted only by the effect of the alteration. The requirements from other sources of the component remain unaffected.

Requirements alteration effectiveness is enhanced by the fact that the alteration to a gross requirement does not continue to cascade through lower levels that are not affected. The system generates and extends lower-level demands in an alteration form. Only items affected by the original alteration are processed. These items are linked together by the level activity table chain.

Component gross requirements that are developed during a normal processing run are stored in the item master file. During a requirements alteration run the affected component gross requirements are adjusted.

Planned orders that are developed during a normal processing run are stored in the item master file. Planned orders affected by requirements alteration processing are adjusted to reflect the alteration.

REQUIREMENTS REPORT PROGRAM

The requirements report program provides the capability of printing the contents of the item master file after the execution of the requirements generation program. Through the use of a parameter record various options pertaining to the amount of information to be included in the report are available. The options include the following: print only items updated in most recent requirements generation run, include or exclude indicative item information, gross requirements, open orders, net requirements, and planned orders. The report produced is called the requirements generation report and is illustrated in Appendix C.

EXCEPTION REPORT PROGRAM

In addition to the requirements report, the exception report is provided by the system. Exception notices are written on disk during execution of the requirements generation program and printed by the exception report program.

The following exception notices are included in the exception report:

1. Gross requirement not processed. Date is outside planning horizon.

2. Open order exists but all gross requirements covered by on-hand inventory.

3. Open order exists this period but gross requirements this period covered by on-hand stock.

4. Open order exists this period but will not cover gross requirements this period.

5. Net requirements exist this period but an open order is due in a future period.

6. Open order is due this period but no gross requirements exists for this period.

7. Requirement offset into a past period. Requirement has been placed in first time period.

8. This open order is not in planning horizon. Considered available in first period.

9. Planned order exceeds maximum quantity to satisfy specific period's requirements.

10. Allocated quantity exceeds available for net. Difference added in first gross period.

11. This quantity is a past due gross requirement that is included in the first time period.

12. Open order is due this period but net requirements exist in past period.

The exception report includes the exception code, item number, and date/quantity.

Certain conditions may arise during a requirements generation program run that merit management attention or review but should not necessarily bring the run to an end-of-job condition. The exception report affords management a tool to analyze conditions that highlight potential problem areas.

The exception report is sorted in exception code sequence and may be sorted by item number within exception code sequence.

REQUIREMENTS PLANNING PHASE SUMMARY OUTLINE

Input

Parameter record
Item master file
Product structure file
Requirements alteration records

Programs

Initialization
Requirements Generation
Requirements Report
Exception Report

Item Master File (Fields Used)

Record activity code
Relative record number of this record
Low-level code
Run activity control number
Relative record number of first assembly component
Relative record number of next item master record in the activity chain
Compare portion of the next item in the activity chain
Item number
Allocated quantity
On-hand total quantity
Carrying rate
Lead time code
Lead time - manufacturing
Lead time - purchasing
Minimum
Multiple
Maximum
Order policy code
Order quantity
Safety stock
Item description
Record identification code
Shrinkage factor
Setup cost
Unit cost
Unit price
Gross requirement fields
Open order fields
Planned order fields

Product Structure File (Fields used)

Relative record number of the component item master
Relative record number of the parent item master
Relative record number of the next assembly record
Compare portion of parent item number
Compare portion of component item number
Quantity per assembly
Lead time adjustment

Output

Updated item master file
Requirements generation report
Exception report
Parameter and level activity table file
Exception file

EXECUTION PHASE

The fourth phase of System/3 Inventory and Requirements Planning relates to the processing of day-to-day transactions that must be recorded in keeping with management's policies regarding order point and order quantity. To accomplish this the item master file must be updated to reflect inventory transactions. Receipts, issues, and adjustments, for example, must be recorded in the file to keep the on-hand inventory current, and balances must be checked to determine whether order action is necessary. In addition, when orders are issued, the transaction must also be recorded.

Reports must be prepared from many levels of management to assist them in their business judgments. A large variety of accounting reports are required for the day-to-day operation and for closing and year-end reporting. In many cases, special outputs and related inputs must be prepared for physical inventory reporting.

The execution phase is provided for keeping the item master up to date and for preparing reports. Two programs are included: transaction processor and status report.

The transaction processor program provides for updating fields in the item master record on the basis of input transactions, while the status report program uses the information stored on the item master record to produce a stock status report.

TRANSACTION PROCESSOR PROGRAM

The transaction processor program accepts transaction input that contains the item number, transaction code, and quantity. On the basis of this input, the program locates the specific item master record, determines the transaction type, updates the item master record, and prints the transaction processor listing. The user may add transactions or modify existing transactions. He is responsible to provide the instructions to support the additional or changed transactions.

Figure 19 illustrates the transactions and their effect on the item master record. Note that the transactions are identified with a code and the item master fields have symbolic labels. The remaining portion of the matrix indicates how the transaction quantity affects the fields on the item master record. Additional transaction codes can be added to each group, and changes to the identification codes can be made if the user desires.

The transaction processor program generates the order action work file on the basis of the status of the inventory items processed during the execution of the program. This file may contain order recommendation, order follow-up, and/or order notice records. Order recommendation records are generated when the available inventory is less than the order point. Order follow-up records are generated if an order recommendation record has previously been generated for an item. Order notice records are generated if the on-hand quantity is less than a percentage of safety stock for items with existing orders.

STATUS REPORT PROGRAM

The status report program prepares a stock status report on the basis of information stored in the item master file. It processes the entire file, or a portion thereof, on the basis of input specifications. The general logic includes sequentially locating each record, processing, editing, and printing the report. The format and contents of the stock status report may be modified if the user desires.

Transactions	Record	Item Master Record							
			On Order			Current Sum Of			
		On Hand	Purchasing	Production	Allocated	Receipts	Issues	Adjustments	Demand
	CODE	MOHTQ	MPUPQ	MPRPQ	MALQT	MCSRE	MCSIS	MCSTA	MCSDE
Work order	11			+					
Work order - adjustment up	01			+					
Cancel work order	12			–					
Work order - adjustment down	02			–					
Receiving report (vendor)	13	+	–			+			
Purchase order	14		+						
Purchase order - adj. up	04		+						
Cancel purchase order	15		–						
Purchase order - adj. down	05		–						
Receipt (production)	16	+		–		+			
Store rework	17	–		+		–			
Return to stock	18	+			+		–		–
Planned disbursement	19	–			–		+		+
Inventory - adjustment up	20	+						+	
Inventory - adjustment down	21	–						–	
Requirement	22				+				
Cancel requirement	23				–				
Miscellaneous receipt	24	+				+			
Miscellaneous issue	25	–					+		–
Customer order	26	–							+
Customer order - adj. up	06	–							+
Cancel customer order	27	+							–
Customer order - adj. down	07	+							–

Figure 19. Representative inventory transactions and their effect on the item master record

SUMMARY - EXECUTION PHASE

The execution phase consists of two basic programs: transaction processor and status report. These programs are run as required to keep the item master file up to date and to prepare the stock status report (see Figure 20). An example of the stock status report is shown in Appendix C.

Input consists of transaction records. Output consists of the transaction listing, stock status report, and order action work file. The programs may be easily modified to expand their capabilities.

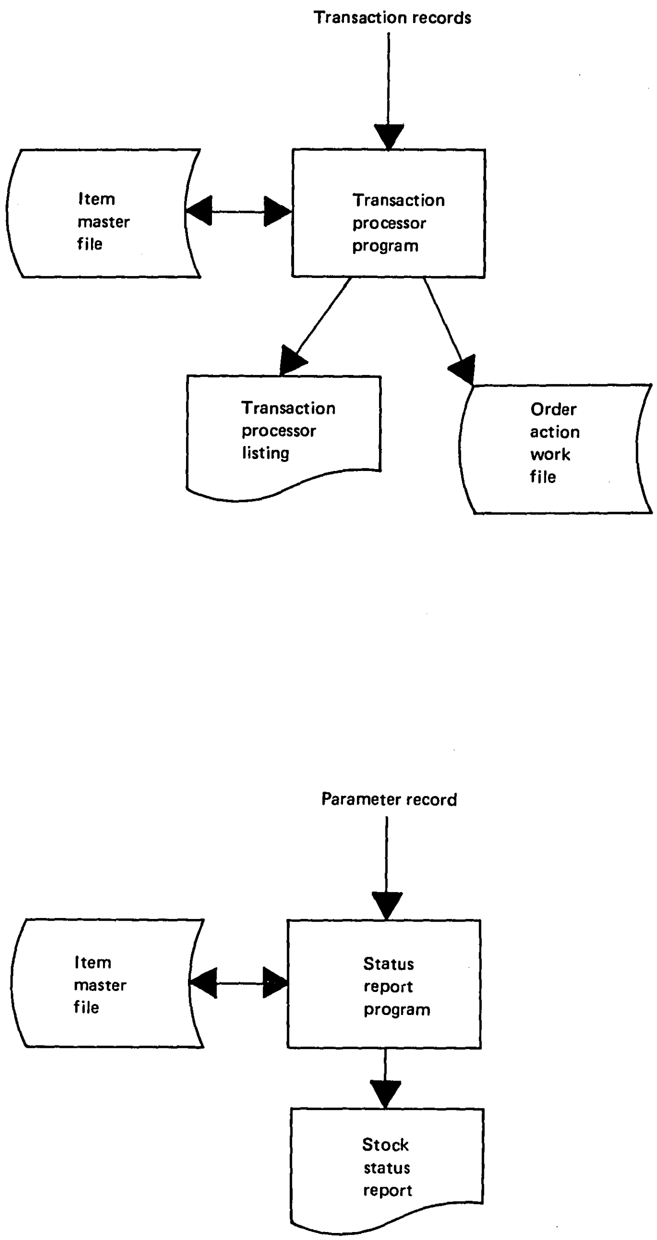


Figure 20. General system chart-execution phase

EXECUTION PHASE SUMMARY OUTLINE

Input

Parameter record
Transaction records (for example, receipts, issues, adjustments, etc.)

Programs

Transaction processor
Status report

Item Master File (Fields Used)

Record activity code
Item number
Allocated quantity
Current sum of demand
Current sum of issues
Current sum of receipts
Current sum of adjustments
Beginning inventory
Model type code
Trend
Lead time code
Lead time - manfacturing
Lead time - purchasing
On-hand total quantity
Minimum
Maximum
Multiple
Order policy code
Order point
Order point recommendation code
Item description
Total on-order production quantity
Total on-order purchasing quantity
Record identification code
Item type
Inventory value classification code
Unit of measure
Order quantity
Safety stock

Output

Updated item master file
Transaction processor listing
Stock status report
Order action work file (recommendations, notices, follow-up)

FILES AND ORGANIZATION

System/3 Inventory and Requirements Planning requires the item master and the product structure files. Both files are contained on direct access storage devices. The item master and product structure files are created and maintained using the System/3 Bill of Material Processor program. Refer to the data base information in the section entitled "User Responsibilities" in this manual for additional information concerning the item master and product structure files. For each file, labels and field descriptions are first listed and then defined. To approximate disk storage requirements refer to Appendix B.

ITEM MASTER FILE

The item master file consists of one record for each unique item number. The record may include any information needed to describe each item number for the engineering, manufacturing, and financial functions. All fields listed beginning with I$ are required by System/3 Bill of Material Processor and are initialized by that program product. The following shows the fields that are used by System/3 Inventory and Requirements Planning:

Label	Field Description	Comments (see note below)	
I$ACD	Record activity code	Required	B
I$RECN	Relative record number of this record	Required	B
I$LLC	Low-level code	Required	B
I$RACN	Run activity control number	Required	B
I$FACA	Relative record number of first assembly component	Required	B
I$FWUA	Relative record number of first assembly where-used	Required	B
I$NMRA	Relative record number of next item master record in the activity chain	Required	B
I$CPMR	Compare portion of the next item in the activity chain	Required	B
I$FROA	Relative record number of first routing operation record	Optional	B
I$PN	Item number	Required	B
I$QTY	Quantity work field	Required	B
MTYPN	Item type	Required	U
MUTMS	Unit of measure	Optional	U
MOPOC	Order policy code	Required	PC
MOQCC	Order quantity category code	Required	PC

Label	Field Description	Comments (see note below)	
MOPOQ	Order quantity	Required	P
MOPRD	Order point recommendation code	Required	P
MOPMN	Minimum	Optional	U
MOPMX	Maximum	Optional	U
MOPMU	Multiple	Optional	U
MPDSC	Item description	Optional	U
MOHTQ	On-hand total quantity	Required	UZ
MALQT	Allocated quantity	Required	UZ
MOPSS	Safety stock	Required	P
MSHRF	Shrinkage factor	Optional	U
MLTPR	Lead time - manufacturing	Required	U
MLTPU	Lead time - purchasing	Required	U
MOPCR	Carrying rate	Required	PM
MUCSU	Setup cost	Required	U
MUCTL	Unit cost	Required	U
MLTCD	Lead time code	Required	U
MCSDE	Current sum of demand	Required	P
MCSIS	Current sum of issues	Optional	P
MCSRE	Current sum of receipts	Optional	P
MCSTA	Current sum of adjustments	Optional	P
MCSBI	Beginning inventory	Optional	P
MFCAL	Alpha factor	Required	PM
MFCFA	First average	Required	P
MFCMD	Mean absolute deviation (MAD)	Required	P
MFCMT	Model type code	Required	U
MFCSA	Second average	Required	P
MFCSD	Sum of deviations	Required	P
MFCSF	Safety factor	Required	PC
MFCTN	Trend	Optional	P
MOPCC	Order point calculation code	Required	PC
MOPOP	Order point	Required	P

Label	Field Description	Comments (see note below)	
MOPRT	Review time	Optional	U
MPJCD	Projection code	Required	U
MPRPQ	Total on-order production quantity	Required	UZ
MPUPQ	Total on-order purchase quantity	Required	UZ
MPUPD	Number of periods of usage	Required	U
MPUQD	Usage quantity	Required	U
MRCID	Record identification code	Optional	U
MTSSC	Tracking signal sequential count	Required	P
MUNPR	Unit price	Optional	U
MVACL	Value classification code	Required	PC
MGR	Gross requirements fields	Required	P
MOO	Open-order fields	Optional	U
MPO	Planned order fields	Required	P

Note: The possible codes which follow the required or optional statement under comments column above are B, P or U. B means that the field must be initialized as required, by System/3 Bill of Material Processor when the file is created. P means that the field will be initialized during the execution of a program. If the letter C follows P, the value is required to be input to the program using a data record. If the letter M follows P, the value is stored in the program but may be modified by the user. U means that the field must be initialized by the user when the file is created. If the letter Z follows the letter U, the field may be initialized to zero. The length of fields coded B is as required by System/3 Bill of Material Processor. The length of fields coded P or U are user specified with the exception of code fields which should be one byte.

ITEM MASTER FILE FIELD DESCRIPTION

I$ACD indicates if the item is active. This field is maintained by System/3 Bill of Material Processor.

I$RECN contains the relative record number of item. This field is used by System/3 Bill of Material Processor.

I$LLC is the low-level code. It is a number indicating the lowest tier or level at which a particular part number is found in all product structure trees. It is used in checking assembly to subassembly continuity.

I$RACN is a data processing run control number.

I$FACA is the relative record number of the product structure record representing the first component of the assembly whose item number is specified by I$PN. Starting with the I$FACA relative record number, all components in the assembly are linked together in an assembly component chain.

I$FWUA is the relative record number of the product structure record representing a usage of this item number on a higher-level assembly. Starting with this relative record number, all direct usages of this item on higher-level assemblies are linked together in an item number where-used chain. This chain is not maintained in any logical sequence, but is built as required by the particular processing program.

I$NMRA is the relative record number of the next item number master record in an activity chain. The activity chain is a temporary chain used in maintaining low-level codes. The chain is also used in summarized explosions and implosions.

I$CPMR is the compare portion of the next item number in the activity chain used to check continuity. It is one character of the item number as selected by the user.

I$FROA is the relative record number of the first routing record. This field is not used by System/3 Inventory and Requirements Planning.

I$PN is the item number that may refer to an assembly or a piece part. The user establishes the size to fit his own particular needs.

I$QTY is the working quantity field used for immediate storage in the summarized retrieval routines. It is required and used by System/3 Bill of Material Processor.

MTYPN is a code used to define the type of item. The possible codes are as follows:

1 - Assembly and subassembly
2 - Fabricated item
3 - Raw material
4 - Purchased item
5 - User option

MUTMS is the unit of measure and defines the units contained in the item master quantity field.

MOPOC is the order policy code applicable to the item, and is used to select the specific ordering logic. The codes used by System/3 Inventory and Requirements Planning are as follows:

A - Discrete order quantity
B - Order point, order quantity
C - Order point, order-up-to level
D - Fixed quantity
F - Part period balancing
G - User option

MOQCC is the code used to determine order cost, carrying rate and the formula used for calculating order quantity.

MOPOQ is the order quantity field. It contains the order quantity to be ordered when the order point is reached. If MOPOC is coded C, this field has the level instead of order quantity.

MOPRD is a code used to indicate that an order recommendation was issued (code 1) or not issued (value other than 1).

MOPMN, MOPMX, and MOPMU are modifier fields that are used to contain the minimum (MOPMN), maximum (MOPMX), and multiple (MOPMU) quantities when order quantity is calculated.

MPDSC is the item number description. It is used to further identify the item on output reports.

MOHTQ is the total quantity of inventory on-hand for this item.

MALQT is the total quantity of inventory that has been allocated or reserved.

MOPSS is safety stock used to protect against the uncertainty in demand and the length of the replenishment lead time.

MSHRF is the factor to be used as a multiplier to adjust the gross requirements to reflect scrap loss, etc.

MLTPR is the total time in shop days required to produce the order; it includes setup, run, and move/queue time.

MLTPU is the time it takes to receive an order for a purchased item from a vendor. It includes internal purchasing cycle and vendor lead time expressed in shop days. This field is required if the calculate offset subroutine is elected.

MOPCR is the carrying rate of the item expressed as a percentage of the annual item cost. It is used in the computation of the economic order quantity (EOQ) for the item. If the order quantity for the item is computed by the time periods of supply method, MOPCR is the number of periods of supply.

MUCSU is the total setup cost that is required by the part-period balancing order policy in the plan orders subroutine.

MUCTL is the unit cost of the item and is used by the part-period balancing order policy in the plan orders subroutine.

MLTCD is a code field to indicate whether purchase lead time (P) or manufactured lead time (M) is to be used. The field is required if the calculate offset subroutine is elected.

MCSDE is the current sum of actual demand for an item (whether satisfied or not) during the current time period.

MCSIS is the running sum of the inventory disbursements made during the current time period.

MCSRE is the running sum of the inventory receipts made during the current time period.

MCSTA is the running sum of the adjustments made to the inventory of the item for the current time period.

MCSBI is the amount in inventory at the beginning of the current time period.

MFCAL is the smoothing constant. It is the weighting factor to be assigned to current data and past demand. The higher the factor the greater the weight given to the recent demand.

MFCFA is the field used in 1st and 2nd order smoothing to smooth the first average.

MFCMD is the mean absolute deviation (MAD). It is the average of the differences between the actual demand and average demand for an item, as determined each time average demand is calculated (for example, every two weeks). All differences are considered positive.

MFCMT is the classification code of model type. Two models exist, horizontal (H) and trend (T).

MFCSA is the field used in 2nd order smoothing to smooth the second average.

MFCSD is the sum of the deviations between actual demand and projected demand as used to determine the accuracy of the projection. Each period deviation is exponentially smoothed into the sum.

MFCSF is a number used for the computation of safety stock. If statistical methods are used, this factor is multiplied by MAD (adjusted by lead time) to determine safety stock. The safety factor may be time or a percentage of lead time which is used with average demand to calculate safety stock.

MFCTN is the result of the trend calculations performed during the update and project program.

MOPCC is the code used to control the method used for calculating the order point. The user is responsible for selecting this code. The selected code determines the method of calculating safety stock, which is a factor in calculating the order point. The codes used in System/3 Inventory and Requirements Planning are as follows:

1 Number of projection intervals
2 Percent of lead time
5 Order service (service level given as %)
7 User method

MOPOP is the order point. It is the quantity expected to be consumed during the replenishment lead time plus a reserve. It is the average demand multiplied by lead time plus safety stock.

MOPRT is the time interval in shop days when an item's order point is compared to the available stock to determine whether order action is necessary.

MPJCD is the code to signal that the item is to be projected (code of 1) or not projected (any other value).

MPRPQ is the total quantity being manufactured for this item.

MPUPQ is the total quantity on order from purchase orders for this item.

MPUPD is the number of periods of demand represented by MPUQD. The period is defined as the length of time of one projection period (for example, one month).

MPUQD is the total demand quantity during the past number of periods (MPUPD).

MRCID is used identify the item master record and is an aid to RPG II.

MTSSC is a count field one byte in length of the number of times the tracking signal is tripped in sequence. It is reset to zero if the tracking signal is not tripped.

MUNPR is the unit price of the item.

MVACL is a code indicating the category of inventory for this item. Stratification of inventory is accomplished by correlating annual demand, investment and net profit.

MGR is the label that references the gross requirements fields. Gross requirements are stored by due date and quantity.

MOO is the label supplied to reference the user-provided open-order fields. Open orders are stored by due date and quantity.

MPO is the label that references the planned order fields. Planned orders are stored by start date and quantity.

PRODUCT STRUCTURE FILE

The product structure file contains one record for each assembly component. Through direct access storage device chaining, one record represents both an assembly component (portion of a bill of material) and the direct usage of the component part on a higher-level assembly. The user may include such information as structure change and effective dates. All fields beginning with P$ are required by the System/3 Bill of Material Processor and must be initialized and be of a length as required by that program product. The length and initial value of field PSLDT are specified by the user. The following shows the fields that are used by System/3 Inventory and Requirements Planning:

Label	Field Description	Comments
P$CMRA	Relative record number of the component item master record	Required
P$PMRA	Relative record number of parent item master record	Required
P$NACA	Relative record number of next assembly component record	Required
P$NWUA	Relative record number of next assembly where-used record	Required
P$PWUA	Relative record number of previous assembly where-used record	Required
P$CPC	Compare portion of the component item number	Required
P$CPP	Compare portion of the parent item number	Required
P$QTY	Quantity per assembly	Required
PSLDT	Lead time adjustment	Optional

PRODUCT STRUCTURE FILE FIELD DESCRIPTION

P$CMRA is the relative record number of the component item master record. The actual item number and other information can be read from the item master record using this relative record number.

P$PMRA is the relative record number of the parent item in the item master file.

P$NACA is the relative record number of the product structure record representing the next component in this assembly. In this manner, all components of an assembly are linked together in an assembly component chain, which began in I$FACA of the parent item number master record.

P$NWUA is the relative record number of the product structure record representing another usage of this component item number on a higher-level assembly. In this manner, all direct usages of an item number are linked together in an item number where-used chain, begun in field I$FWUA of the component item number master record.

P$PWUA is the relative record number of the product structure record representing another usage of this item number on a higher-level assembly. In this manner, all direct usages of an item number are linked together in a reverse item number where-used chain. The function of this reverse chain is to reduce computer time required in product structure file maintenance.

P$CPC is the compare portion of the item whose usage is represented by this product structure record.

P$CPP is the compare portion of the parent item number and is used for checking purposes.

P$QTY is the quantity of this component used on this parent assembly.

PSLDT is the lead time adjustment of the component in relation to the parent item as indicated by this product structure record. The field is required if the product structure offset adjustment option has been elected in the requirements generation program.

ANALYSIS WORK FILE

The analysis work file is a temporary disk file created by the inventory analysis - usage extension program. Each record contains item number, annual usage, unit cost, annual inventory value, unit price, and secondary calculation value. The secondary calculation value, based on user option specified in the parameter record, contains the product of annual usage and unit price or the product of on-hand and unit cost. The analysis work file should be sorted by annual value in descending order before it is used as input to the inventory analysis - report program.

EXCEPTION REPORT FILE

The exception report file is a temporary disk file containing the exception notices and is created by the requirements generation program. Before using it as input to the exception report program, it may be sorted. The exception report file is a consecutively organized disk file, with each record containing exception code, item number, date, and quantity. The user has the option to sort by item number or by item number within exception code.

ORDER ACTION WORK FILE

The order action work file is a temporary disk work file created by either the order point program or the transaction processor program. The file may contain order recommendation, order follow-up, and/or order notice records which are created on the basis of the inventory status of the items processed during execution of either program. This file is a temporary file because it is created each time either program is executed. The user may list, sort, and/or reformat the records of this file for use in other programs.

PARAMETER AND DATA RECORDS

Two types of input records are used by the program product in addition to the files discussed above: parameter records and data records. The parameter records are used to elect options within a program, select specific records for processing, and specify whether the item master file should be updated during the program execution.

Data records are used as input to provide the capability of updating various fields of specific item master records, or initializing tables prior to program execution. These include code definition, update, category code, requirements alteration, and transaction records.

USER RESPONSIBILITIES

System/3 Inventory and Requirements Planning is a vital link in any production information and control system. Its output of planned orders may become the data input to production and purchasing functions. It is extremely important that this output be accurate. Accuracy can be attained only through the use of a well maintained data base, valid input, and a thorough understanding of the results of electing the options that are provided by System/3 Inventory and Requirements Planning.

DATA BASE

Through the use of the System/3 Bill of Material Processor the data base which includes the item master file and product structure file can be created and efficiently maintained for a production control system. It is the responsibility of the user to select the fields required and to assure that the data is kept accurate.

The item master file and the product structure file are created by the System/3 Bill of Material Processor to provide a linkage between the two files. This linkage is required only for the requirements planning phase of the program product. If the user does not desire the requirements planning phase, the product structure file is not required. In this situation the user could create the item master file using the System/3 Disk System capability or the System/3 Bill of Material Processor.

The collection and proof of the information to be used for the creation of the files can be a major undertaking. The need for accurate input data cannot be over-emphasized; therefore, to ensure accuracy it is recommended that the input data be proved offline before it is used to create the files.

When the information available or needed for each file has been determined, the user can design the record formats. Space should be provided for additional information if new applications are to be added. This will save reloading or recreating the files.

Open orders are needed by the system to provide an accurate evaluation of net requirements in a time series planning environment. The accuracy of the open orders affects the accuracy of the planned orders. It is important, therefore, that the open orders be carefully maintained. For purpose of identification, all outstanding orders that have been reviewed by management are classified by System/3 Inventory and Requirements Planning as open orders. They could consist of unreleased and released production orders, as well as purchase requisitions and purchase orders. Each user's unique situation dictates when purchase requisitions and unreleased orders should be classified as open orders. It is the user's responsibility to review planned orders and convert them to open orders, as well as to maintain the open orders themselves.

It is important to note that System/3 Inventory and Requirements Planning assumes that all of the necessary components will be available to complete open orders. If allocation is performed at the time planned orders are converted to open-order status, the component requirements to satisfy that order must be allocated.

INPUT

Input data to the programs, in addition to the files, is provided in parameter and data records. The user may add data fields to the input records but he is responsible for providing the program code to process this data.

The update and project, order point, and order quantity programs require historical usage data. The potential user should take steps to accumulate as much data as possible so that it is available when these programs are implemented.

Input to the initialization and requirements generation programs represents the gross requirements for end items and service part usage of lower-level items.

The accuracy of the input is reflected in the accuracy of the output. Many excellent forecasting methods have been developed that provide an ideal basis for input. The update and project program of the projection phase can provide this type of input to the requirements planning phase. Not to be overlooked is the forecast input that can be provided from a marketing department of a manufacturing organization.

Service part usage, as defined here, means any usage of an item that is not developed from generation of requirements of high-level items. If the method of providing service part requirements is derived from forecasting demand, it is necessary to provide a procedure to distinguish the history of the service part item from service usage and normal manufacturing usage.

OUTPUT

Reports to assist management in making business decisions must be prepared. There are a large variety of such accounting reports that are necessary for the day-to-day business operation, as well as for closing and year-end physical inventory reporting. The quantity, type, and frequency of these reports are dictated by the needs and the demands of the user. The program product provides many of the necessary reports. The user may make coding changes to modify these reports to suit his needs. It is the user's responsibility to write the programs to produce any additional reports determined to be necessary.

The order action work file is a temporary disk work file created by either the order point program or the transaction processor program. It may contain order recommendation, order follow-up, and/or order notice records which are created on the basis of the inventory status of the items processed during execution of either program. This file is created each time either program is executed. For this reason the user must process the order action work file before reexecuting either the order point program or the transaction processor program. The user may desire to reformat, sort, and/or list the records of the order action work file and/or create documents to take action to rectify the status of the items contained in this file. Since the file could be utilized in various ways, it is the user's responsibility to write the programs to process this file.

SELECTION OF PLANNING OPTIONS

The descriptions of system functions and their options have been presented in the sequence that they are performed so that the system can be seen in its entirety. Careful study and review of the options will provide sound knowledge as to their usefulness. By reviewing the options that are available in System/3 Inventory and Requirements Planning, it can be seen that most options require detailed information and, therefore, give a detailed result.

The selection of options is accomplished through the use of parameter records. The user, after examining the options, is responsible for entering the proper codes in the various parameter records to select the options of his choice.

If the potential user is not familiar with the techniques used for order quantity and order point computation and for exponential smoothing, he should review material that explains these concepts in more detail. The bibliography lists several excellent references. The user should be prepared to make judgments regarding the cost of carrying inventory and order cost for order quantity calculations, the selection of an alpha factors for projection, and the level of service desired for order point. This must be done in addition to having specific information for review time, lead time, item cost, etc.

Other options adjust requirements because of predetermined conditions, such as a shrinkage factor temporarily adjusting gross requirements before netting against open orders. The planned orders subroutine has several order policies and modifiers that require a great deal of investigation before they can be properly applied to specific items. Requirements alteration processing allows for adjusting gross requirements.

One method of determining the results of elected options is to use System/3 Inventory and Requirements Planning as a simulator as well as an operating program in a production control system.

Because of the time involved to establish an accurate data base and accurate product structure information, the use of System/3 Inventory and Requirements Planning as a simulator before its installation provides a practical way to arrive at decisions that are required for a sound system. After installation, the simulation concept is an ideal approach to analyze the impact of introducing new product lines.

The throughput speed of the programs for the System/3 Inventory and Requirements Planning program product will differ due to variations in the input data (for example, demands per item) between users. For this reason specific timing estimates are not provided. In order to assist the user in preparing timing estimates, the primary factors that should be considered are discussed below.

The System/3 Inventory and Requirements Planning program product includes initializing and operational programs. Inventory analysis is designed to be used once to set up the system, then periodically (perhaps yearly) or as required to meet changing conditions. The order point and update and project programs are run on a regular basis (for example, every month or every two weeks). The frequency of using the order quantity program depends upon the user's requirements. Normally the items considered as having a fixed order quantity would be processed once or twice a year. This is true if the present order quantities are consistent with management's ordering policy. If the order quantities are not considered economical, this program with its analysis for implementation feature will be used from time to time until the order quantities agree with the policy.

The inventory analysis - usage extension program sequentially reads the item master file, accepts usage information from the item master record, and creates the disk analysis work file. Timing for this program can be based on the access and read time for the item master file and the time it takes to write the sequential output in the disk analysis work file.

The timing estimate for the IBM System/3 Disk Sort is based on the number of the work records that were created by the usage extension program.

The inventory analysis - report program reads the file of sorted work records and prints the ABC analysis report. The speed of the printer is the primary consideration for timing this program.

The inventory analysis - classification program sequentially reads and updates the item master file and assigns codes to the item master records based on the user-specified breakpoints for A, B and C type items. These codes are contained on code definition records and are read into a table in core storage. An audit listing is prepared that indicates the item number, description, and the code assigned to each item. The timing estimate should consider the time to read the code definition records (maximum of 10), the time to access, read, and write the item master record, and the time to print one line on the audit report for each item.

The inventory analysis - update program provides for modification of the codes assigned by the inventory analysis - classification program. All or a portion of the codes may be changed in an item master record by using the update record. One line is printed on an audit list for each item updated. The timing estimate should consider the time to read the update records (one for each item master record to be changed), randomly retrieve the item master record, update it and print a line on the audit list for each item changed.

The order point program is normally used to sequentially process all or selected items of the item master file. One report line is printed for each item unless the analysis for implementation option is specified, in which case two lines are printed for each item. Order action work file records may be created on the basis of the inventory status of the items processed. The major elements of timing to be considered are disk file access, read and write times, the number of order action work file records, and the number of report lines printed for each item.

The order quantity program sequentially processes all or selected items of the item master file. One report line is printed for each item except when the analysis for implementation option is specified, in which case a second line is printed for each item. The timing elements should consider disk file access and read/write times plus the number of report lines printed for each item.

Timing estimates for the update and project program should consider disk file access, read and write times, as well as the amount of time it takes to print the projection report. The report may include several lines for each item if the projection of future demand is printed.

Because of the random processing required by the programs in the requirements planning phase the processing time of the programs is dependent on the input/output disk operations, printing, and data record input. For this reason, the considerations are directed toward establishing input/output timings.

The initialization program, in a normal run, sequentially reads and updates the item master file and creates a level activity table in core storage. The level activity table is written on a disk file at the conclusion of processing the item master file. The program in a requirements alteration run reads requirements alteration input records, randomly reads and updates the necessary item master records, and builds the level activity table in the same manner as in the normal run. Timing estimates should include the disk file access, read and write times for the item master file. The time to write the level activity table on disk is negligible as it is a one-record file.

The requirements generation program is the most time-consuming program and requires more complete knowledge of the variables to be considered in estimating run time. The most important consideration in this program is to accurately estimate the number of items that will be processed in order to arrive at the disk file access read and write times. Since the requirements generation program is using low-level coding to determine the net requirements of an item once (at its lowest level), it is suggested that separate timing considerations be made for each level. To arrive at this, the user should know the average number of levels in the product structure file and the number of items at each level of an individual product structure that are at the item's lowest level of usage. This result should then be reduced by the number of items at a level that do not generate any component requirements. The end result is the approximate number of items that will be input at each level.

In addition to the input, it should be known how many direct components go into an item in order to determine the number of seeks, reads, and writes required to retrieve the parent item's product structure records and the components' item masters. Once this is determined, the number of items updated as a result of processing a level can be approximated. Direct addressing using the relative record number is used to retrieve the item as input to a level; therefore, one seek is used for each input item.

Once all of the above-mentioned variables have been supplied, the user can determine for each level the number of seeks and reads required for input to each level and the number of seeks, reads, and writes reqired for output to each level. To determine how much time is required to retrieve or write a record, additional characteristics of the records must be known. These include the blocking factor and distribution of the items on the files. The total input time should be adjusted by a factor that would indicate the possibility that the record being retrieved is included in core in the block previously read or located in the same cylinder as the record previously read. An additional consideration for output to a file is whether or not the access arm must be repositioned to write the record back on the file.

The requirements report program sequentially reads the entire item master file and prints the items that the user has selected. For this discussion assume the printing of all items that have been active during this run. Consider the time to read the item master file sequentially. The number of items to be printed is the number of items that are input to each level, as determined in the requirements generation program. For print time, determine the number of lines to be printed for each item, and consider total print time per line in arriving at the total time to print one item. By multiplying this result by the number of items to be printed, the approximate total print time for the requirements report program is determined. Add the total print time to the total file read time to complete the requirements report program timing.

The exception report program sequentially reads the exception file and produces the exception report. The time required is essentially the total file read time and the total print time.

The transaction processor program reads transactions, reads the related item master record and writes the updated item master record and a report and may create order action work file records. Calculation time is negligible. The processing time will depend on the number of transactions. The timing should consider all of the above.

The status report program reads the item master file sequentially and writes a line for each item. The time required is essentially the print time for the number of items.

CONTROL, AUDIT, AND RECONSTRUCTION PROCEDURES

All input and output operations and associated error checking are performed using the standard input/output support of the System/3 Disk System Management.

The programs include the ability to count the number of records processed and to print certain control totals on reports.

The user should prepare a backup copy of the item master and product structure files for reconstruction purposes. The frequency of preparing the backup copy of the files depends upon the requirements of each installation. Audit lists are part of the normal reports of all programs that update the item master and product structure files. The user should save all input that updates the files between backup copies of the files for reconstruction purposes.

PROGRAMMING SYSTEMS

The programs required for the compilation and execution of the System/3 Inventory and Requirements Planning are:

Program Name	Model 10 Program Number	Model 6 Program Number
System/3 Disk System Control Program	5702-SC1	5703-SC1
System/3 Disk RPG II Program	5702-RG1	5703-RG1
* System/3 Model 6 Conversational Utilities Programs		5703-UT1
System/3 Disk System Disk Sort Program	5702-SM1	5703-SM1

The program product provides source code, written in RPG II. The System/3 Bill of Material Processor (5702-M41) is required for the creation and maintenance of the item master and product structure files when all phases of the program product are implemented. If the user is implementing only the inventory control capability of the program, the programs of the requirements generation phase are not used and the product structure file is not required. The item master file may then be created and maintained using either the file creation and maintenance capability of System/3 Disk System RPG II or the System/3 Bill of Material Processor program product.

*The System/3 Model 6 Conversational Utilities Programs are required for data file preparation for Model 6 systems that do not have the IBM 5496 Data Recorder, Model 1, with the System/3 Model 6 On-Line Feature.

MINIMUM MACHINE CONFIGURATION

The minimum configuration for the System/3 Inventory and Requirements Planning program product using the System/3 Model 10 is:

Device Or Feature	
Processing Unit (16K)	5410 A14
Multi-Function Card Unit Attachment	4100
Printer Attachment	3970
Multi-Function Card Unit	5424 Model A1
Printer	5203 Model 1
Printer Attachment	5558
Disk Storage Drive	5444 Model 1

The minimum configuration for the System/3 Inventory and Requirements Planning program product using the System/3 Model 6 is:

Device Or Feature	
Processing Unit (16K)	5406 B4
Printer Attachment	3901
Printer (85 CPS)	5213 Model 1
Disk Storage Drive	5444 Model 1

For card I/O on the System/3 Model 6, in addition to the minimum system, the 5496 Model 1 Data Recorder with attachment 7501 is required, and attachment 3210 is required for the 5406 processing unit.

Sufficient disk capacity is needed to contain the required system and application programs, work files, and user data files. Tables 1 and 2 in Appendix B may be used to aid in determining the needed capacity. The requirements for single drive systems and/or for Model 6 systems may require special consideration. In addition, consult the appropriate System/3 manuals to determine total file requirements.

For the Model 6, special consideration must be given to the user's input/output volume requirements, with respect to the equipment capabilities. The speed of the I/O devices (for example, the printer and data recorder) has a significant effect on the overall throughput, and must be thoroughly examined and evaluated relative to the user's overall system requirements.

In addition to the System Control Program, a minimum of 13K bytes is required to compile and execute the programs. Some programs utilize the Overlay Editor of RPG II.

For the Model 10 user, improved performance will result with additional core storage capacity as the overlay requirements are reduced or eliminated.

APPENDIX A: FORMULAS

Item Master Record Fields
MFCFA = First average
MFCSA = Second average
MFCMD = Mean absolute deviation (MAD)
MFCSD = Sum of deviations
MCSDE = Current sum of demand
MFCAD = Average demand
MFCTN = Trend
MFCAL = Alpha factor

HORIZONTAL UPDATING

First average
New MFCFA = Old MFCFA + MFCAL (MCSDE - Old MFCFA)
Average demand
New MFCAD = New MFCFA

TREND UPDATING

First average
New MFCFA = Old MFCFA + MFCAL (MCSDE - Old MFCFA)
Second average
New MFCSA = Old MFCSA + MFCAL (New MFCFA - Old MFCSA)
Average demand
New MFCAD = 2 x New MFCFA - New MFCSA
Trend

$$\text{New MFCTN} = \frac{(\text{New MFCFA} - \text{New MFCSA})}{\left(\frac{1-\text{MFCAL}}{\text{MFCAL}}\right)}$$

MAD AND SUM OF DEVIATIONS UPDATING

Mean absolute deviation
New MFCMD = Old MFCMD + MFCAL (CD - Old MFCMD)

where:

Current deviation or CD = MCSDE - Old MFCAD
and
Old MFCAD = Old MFCFA (for horizontal)
Old MFCAD = 2 Old MFCFA - Old MFCSA (for trend)
Current deviation is an absolute value

Sum of Deviations

New MFCSD = Old MFCSD + MFCAL (CD - Old MFCSD)

where:

Current deviation or CD = MCSDE - Old MFCAD
Tracking signal

$$\text{TS} = \frac{\text{New MFCSD}}{\text{New MFCMD}}$$

PROJECTING FUTURE TIME PERIODS

1 = MFCAD + 1 MFCTN
2 = MFCAD + 2 MFCTN
•
•
•
n = MFCAD + n MFCTN
If horizontal, MFCTN = 0; MFCAD is projection for all periods.

ADJUSTMENT FOR CHANGE IN ALPHA (MFCAL)

Horizontal - no adjustment
Trend - adjust MFCFA and MFCSA

First average

$$\text{New MFCFA} = 2\ \text{Old MFCFA} - \text{Old MFCSA} - \left(\frac{1-\text{New MFCAL}}{\text{New MFCAL}}\right) \times \text{MFCTN}$$

Second average

$$\text{New MFCSA} = 2\ \text{Old MFCFA} - \text{Old MFCSA} - 2\left(\frac{1-\text{New MFCAL}}{\text{New MFCAL}}\right) \times \text{MFCTN}$$

where:

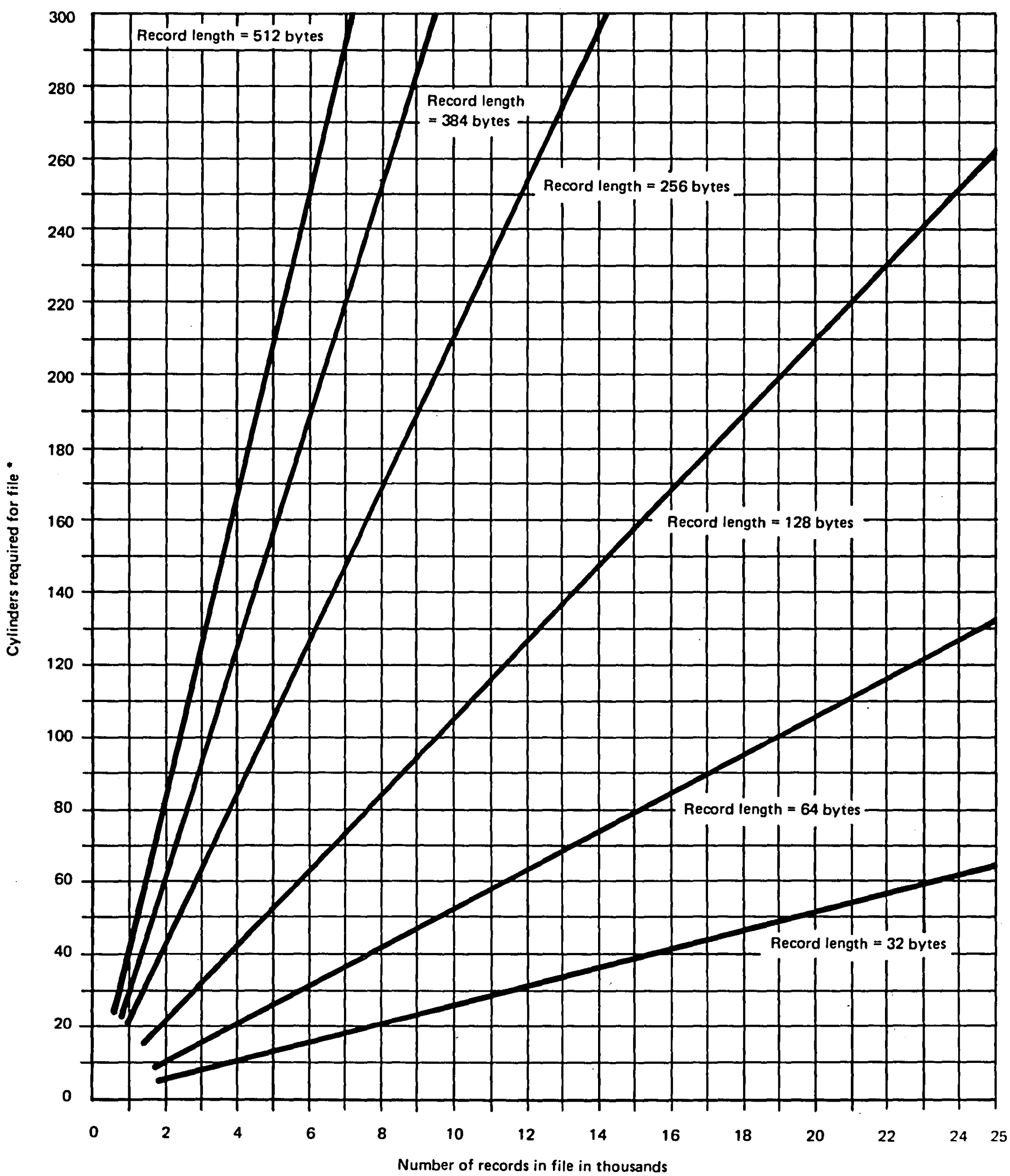
$$\text{MFCTN} = \frac{\text{Old MFCAL}}{(1-\text{Old MFCAL})} \times (\text{MFCFA}-\text{MFCSA})$$

APPENDIX B: DISK STORAGE REQUIREMENTS

Two tables are provided as an aid for estimating disk storage requirements for System/3 Inventory and Requirements Planning. Table 1 can be used to quickly approximate the number of cylinders required to store a given number of records of various record lengths. To use Table 1 select along the horizontal axis the line which represents the number of records to be stored in a file. Follow the selected line until it intersects the diagonal line which most closely represents the desired record length. Follow the closest horizontal line to the left and read the number of cylinders required to contain the file.

As an example, assume that the item master file must contain 4,000 records of a length of 384 bytes and the product structure file must contain 15,000 records of a length of 32 bytes. Table 1 indicates that approximately 125 cylinders of disk storage would be required for the item master file and approximately 40 cylinders of disk storage would be required for the product structure file.

Table 1. File Allocation



* Record storage area only; index area for indexed file is not included.

Table 2 is provided to determine the number of tracks or cylinders required to contain the index of an indexed sequential file. An index record, which consists of a record key and a three-byte disk address, must be present in the index for every record in an indexed sequential file. The index of an indexed sequential item master file of 4,000 records contains 4,000 index records in the index. To use Table 2 read down the column labeled key length to the required key length and read across to the number of index records in a track or a cylinder for that key length. Divide the number of records in the file by the number of index records per track or cylinder to determine the number of tracks or cylinders required to contain the index. The results should be rounded out to the next whole number.

As an example, assume the item master records discussed previously in the example for Table 1 contained a key length of 9 bytes. Table 2 indicates that 504 index records can be contained on one track or 1008 index records can be contained on one cylinder. Dividing 4000 by 504 and 1008 and rounding out results in 8 tracks or 4 cylinders, respectively, required to contain the index.

Table 2. Index Area for Index Sequential Files

Key Length In Bytes	Index Records		
	Per Sector	Per track	Per cylinder
2	51	1224	2448
3	42	1008	2016
4	36	864	1728
5	32	768	1536
6	28	672	1344
7	25	600	1200
8	23	552	1104
9	21	504	1008
10	19	456	912
11	18	432	864
12	17	408	816
13	16	384	768
14	15	360	720
15	14	336	672
16	13	312	624
17	12	288	576
18	12	288	576
19	11	264	528
20	11	264	528

APPENDIX C: SAMPLE REPORTS

Samples of the major reports produced by the programs of System/3 Inventory and Requirements Planning are illustrated on the following pages. The reports are grouped by phase and the program generating the report is indicated.

INVENTORY PLANNING PHASE

Inventory analysis report	Inventory analysis - report program
Order point report	Order point program
Order quantity report	Order quantity program

PROJECTION PHASE

Projection report	Update and project program

REQUIREMENTS PLANNING PHASE

Requirements generation report	Requirements report program

EXECUTION PHASE

Stock status report	Status report program

INVENTORY ANALYSIS REPORT

This report provides a list of all selected items in the item master file sorted in descending sequence by annual usage dollars. The report shows the investment in inventory breakdown; the report shows that a high percentage of dollar value of annual usage is concentrated in a relatively few items at the beginning of the report. At the end of the report a high percentage of items account for a small amount of annual usage dollars.

On the basis of this report the inventory items can be segmented in order that different levels of control can be applied to the various groups of items.

INVENTORY ANALYSIS REPORT   ICRP MANUFACTURING COMPANY   1/05/72   PAGE 1

ITEM NUMBER	DESCRIPTION	ITEM COUNT	CUM % ITEMS	ANNUAL UNITS	UNIT COST	ANNUAL USAGE $	CUMULATIVE USAGE $	CUM % USAGE $	ANN USE PRICE $	CUM % VALUE
9900002M	PAINT SPRAY UNIT	1	.9	4,951	49.500	245,075	245,075	13.5	643,630	15.1
9900002A	PAINT SPRAY UNIT	2	1.8	3,974	47.500	188,765	433,840	23.9	516,620	27.2
2700005-M	PUMPING UNIT	3	2.7	9,744	17.300	168,571	602,411	33.2	379,285	36.0
2700003-20	PUMP ASSEMBLY	4	3.6	9,936	11.200	111,283	713,694	39.3	250,387	41.9
2700005-A	PUMPING UNIT	5	4.5	6,192	17.950	111,146	824,840	45.4	250,082	47.8
03370	MOTOR	6	5.4	9,000	7.250	65,250	890,090	49.0	146,817	51.2
2700007-A2	BASE	7	6.3	9,435	5.400	50,949	941,039	51.8	114,635	53.9
2700006-23	TANK	8	7.1	4,872	8.300	40,438	981,477	54.0	90,985	56.0
9900003M	PAINT SPRAY UNIT	9	8.0	705	49.500	34,898	1,016,375	56.0	78,519	57.8
A3425	TANK COVER ASSEMBLY	10	8.9	9,504	3.610	34,309	1,050,684	57.8	77,201	59.7
9900003A	PAINT SPRAY UNIT	11	9.8	705	47.500	33,488	1,084,172	59.7	75,347	61.4
2700006-22	TANK	12	10.7	3,974	8.300	32,984	1,117,156	61.5	74,214	63.2
2700000-02	COMPRESSOR	13	11.6	9,792	3.050	29,866	1,147,022	63.2	67,202	64.7
2700007-A1	BASE	14	12.5	5,449	5.400	29,425	1,176,447	64.8	66,205	66.3
2700006-21	TANK	15	13.4	3,206	8.300	26,610	1,203,057	66.2	59,872	67.7
2700006-82	TANK BOTTOM	16	14.3	6,506	3.810	24,788	1,227,845	67.6	55,776	69.0
A3425-9	TANK COVER ASSEMBLY	17	15.2	6,744	3.610	24,346	1,252,191	68.9	54,782	70.3
9900001A	PAINT SPRAY UNIT	18	16.1	504	47.500	23,940	1,276,131	70.3	53,865	71.5
2700006-24	TANK	19	17.0	2,832	8.300	23,506	1,299,637	71.6	52,888	72.8
2700000-01	COMPRESSOR	20	17.9	7,512	3.050	22,912	1,322,549	72.8	51,555	74.0
3415-2	SPRAY NOZZLE	21	18.8	13,690	1.550	21,220	1,343,769	74.0	47,751	75.1
2700006-83	TANK BOTTOM	22	19.6	5,532	3.810	21,077	1,364,846	75.1	47,426	76.2
9900001M	PAINT SPRAY UNIT	23	20.5	415	49.500	20,543	1,385,389	76.3	46,221	77.3
3415-1	SPRAY NOZZLE	24	21.4	13,035	1.490	19,422	1,404,811	77.3	43,706	78.3
2700006-85	TANK BOTTOM	25	22.3	4,968	3.810	18,928	1,423,739	78.4	42,591	79.3
03903	INPELLER	26	23.2	8,220	1.950	16,029	1,439,768	79.3	36,069	80.2
03021	VALVE	27	24.1	8,486	1.850	15,699	1,455,467	80.1	35,327	81.0
03428-9	STAND	28	25.0	6,108	2.500	15,270	1,470,737	81.0	34,358	81.8
2700006-01	TANK TOP	29	25.9	7,358	2.010	14,790	1,485,527	81.8	33,280	82.6
A3348	CONTROL BOX	30	26.8	10,008	1.450	14,512	1,500,039	82.6	32,656	83.3
3415-3	SPRAY NOZZLE	31	27.7	[illegible]	[illegible]	[illegible]	[illegible]	83.4	32,360	84.1
03424-9	TREADLE ASSEMBLY	51	45.5	3,564	1.700	6,059	1,707,358	94.0	13,632	94.3
03640	HINGE WASHER	52	46.4	59,186	.090	5,327	1,712,685	94.3	12,015	94.5
03443	MOTOR SUPPORT	53	47.3	6,790	.710	4,821	1,717,506	94.6	10,850	94.8
2700006-20	TANK	54	48.2	552	8.300	4,582	1,722,088	94.8	10,309	95.0
78053	WHEEL NUT	55	49.1	63,600	.070	4,452	1,726,540	95.1	10,049	95.3
03425	COVER	56	50.0	8,446	.450	3,802	1,730,342	95.3	8,558	95.5
03905	WEARING COLLAR	57	50.9	37,695	.100	3,770	1,734,112	95.5	8,481	95.7
03906	DRIVING COLLAR	58	51.8	35,686	.100	3,569	1,737,681	95.7	8,030	95.9
07652	STAND-FRAME SCREW	59	52.7	70,635	.050	3,532	1,741,213	95.9	7,982	96.0
03011	THROW-OFF COLLAR	60	53.6	34,892	.100	3,489	1,744,702	96.1	7,851	96.2
07[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.060	[illegible]	[illegible]	[illegible]	6,920	96.4
03410	BRACKET	101	90.2	11,672	.050	584	1,812,186	99.8	1,319	99.8
86813	NUT	102	91.1	14,014	.040	561	1,812,747	99.8	1,261	99.8
89182	HANDLE SCREW	103	92.0	11,115	.050	556	1,813,303	99.8	1,256	99.8
03578	TREADLE SPACER	104	92.9	6,164	.090	555	1,813,858	99.9	1,251	99.9
2700006-80	TANK BOTTOM	105	93.8	144	3.810	549	1,814,407	99.9	1,235	99.9
03902	PUMP SHAFT PIN	106	94.6	11,999	.040	480	1,814,887	99.9	1,080	99.9
2700007-22	FRAME	107	95.5	165	2.050	338	1,815,225	99.9	761	99.9
03901	SET SCREW	108	96.4	6,164	.050	308	1,815,533	100.0	697	100.0
03417	BOLT	109	97.3	6,109	.040	244	1,815,777	100.0	550	100.0
03592	PIN	110	98.2	5,827	.040	233	1,816,010	100.0	524	100.0
03907	SEAL	111	99.1	4,449	.050	222	1,816,232	100.0	503	100.0
2700001-01	ADAPTOR PLATE GASKET	112	100.0	2,536	.020	51	1,816,283	100.0	114	100.0
	TOTALS	112					$1,816,283		$4,271,345	

ORDER POINT REPORT

The order point report provides at least one line of significant information for each item selected; based upon the selection codes supplied in the parameter record and a calculation performed by the program, one or two additional lines may be printed.

The first line lists the item number and description, with codes for model type (M) and order point calculation (O). In addition to the safety stock and order point calculated for the current period, the first line includes safety factor, average demand, mean absolute deviation (MAD), on hand, available stock and the index value. The index value may show a value and/or a code or a group of asterisks. The codes mean that an order recommendation record (R), a follow-up record (F), or a notice record (N) has been written on the order action work file. The asterisks indicate that the item has an order policy code of other than order point.

The second line of information for each item is printed when the analysis for implementation option is elected in the parameter record. It shows the dollar value of the new and old safety stock quantity, order point calculation code, safety factor, lead time, the safety stock and order point quantities from the previous period, the positive or negative dollar value difference of the current and previous safety stock quantity, and the unit cost of the item.

The analysis for implementation feature permits the report to be produced without updating the file. The order point calculation code and/or safety factor may be changed between runs of the order point program to analyze the effect of different values. When the report shows satisfactory results, the program can be rerun to update the item master file with selected values for the calculation code or safety factor.

The third line shown on the report for an item is printed when the new order point value differs from the old order point value by a fixed percentage. The difference highlights items with a significant change in the order point quantity. The information printed on this line is similar to the information printed on the second line except that the dollar value is shown for the new and old order point quantities and their difference. If the analysis for implementation option is not elected in the parameter record, only this and the first line for each item would be shown on the report.

Information summarizing the report is printed on the final page of the report. In addition to statistics on the number of items processed and the number of different types of order action records produced, the evaluation of old and new safety stock dollars and their difference is provided.

ORDER POINT REPORT IRP MANUFACTURING CO. 1/26/71 PAGE 1

ITEM NUMBER	DESCRIPTION	CODES M-O	SFTY FACT	LEAD TIME	SAFETY STOCK	ORDER POINT	AVERAGE DEMAND	MAD	ON HAND	AVAIL STOCK	INDEX VALUE
A3348	CONTROL BOX	T 1	1.5	.7	771	1,102	500.0	100.0	658	58	R
$2,274 NEW SS	$590 OLD SS	1	1.5	.7	200	200	$1,684 SS DIFF			2.950	U/C
$3,251 NEW OP	$590 OLD OP	1	1.5	.7	200	200	$2,661 OP DIFF			2.950	U/C
A3349	CONTROL BOX - PROBE	H 2	95%	.4	38	78	100.0	25.0	10	120	.4 N
$60 NEW SS	$318 OLD SS	2	95%	.4	200	100	$258-SS DIFF			1.590	U/C
A3414	CLAMP WITH NUT	T 1	2.0	.4	617	739	300.0	100.0	500	712	R
$43 NEW SS	$7 OLD SS	1	2.0	.4	100	400	$36 SS DIFF			.070	U/C
$52 NEW OP	$28 OLD OP	1	2.0	.4	100	400	$24 OP DIFF			.070	U/C
A3418	RUBBER TUBE - 1 IN.	T 5	95.0%	.3	264	571	1,214.0	300.0	780	980	.3
$69 NEW SS	$260 OLD SS	5	95.0%	.3	1,000	2,000	$191-SS DIFF			.260	U/C
$148 NEW OP	$520 OLD OP	5	95.0%	.3	1,000	2,000	$372-OP DIFF			.260	U/C
A3425-9	TANK COVER ASSEMBLY	T 1	2.5	.9	1,275	1,730	500.0	100.0	600	800	F
$5,228 NEW SS	$6,150 OLD SS	1	2.5	.9	1,500	500	$922-SS DIFF			4.100	U/C
$7,093 NEW OP	$2,050 OLD OP	1	2.5	.9	1,500	500	$5,043 OP DIFF			4.100	U/C
A3444	STANDPIPE	T 1	.6	.7	1,472	3,068	2,400.0	300.0	800		******
$3,386 NEW SS	$4,600 OLD SS	1	.6	.7	2,000	8,600	$1,214-SS DIFF			2.300	U/C

ORDER POINT SUMMARY REPORT IRP MANUFACTURING CO. 1/26/71 PAGE 2

NUMBER OF ITEMS	127
NUMBER OF SELECTED ITEMS	13
NUMBER OF VALID ITEMS	12
NUMBER OF ORDER RECORDS	4
NUMBER OF FOLLOW RECORDS	1
NUMBER OF NOTICE RECORDS	1
NUMBER OF VARIANCE CHECKS	5
EVALUATION RECOMMENDED ORDERS	$19,578
EVALUATION ON-HAND	$7,746
EVALUATION SAFETY STOCK NEW	$21,143
EVALUATION SAFETY STOCK OLD	$26,062
DIFFERENCE NEW-OLD SAFETY STOCK	$4,919-

ORDER QUANTITY REPORT

Based upon the selection codes in the parameter record, the order quantity report provides one or two lines of information for each item selected. The first line lists the item number and description, the order quantity calculated for the current period and dollar value for that quantity, number of orders placed annually and the annual order cost, on hand, unit cost, annual use, implied carrying rate (ICR), order policy code (OP), and the order quantity category code (CD).

The asterisk to the left of the item description indicates that the order quantity category code input to the program on the category code record is not compatible with order policy code for this item. For this reason, the item is not updated by the program.

A second line is printed for each item when the analysis for implementation option is selected in the parameter record. It shows the order quantity, dollar value, annual orders and annual cost and implied carrying rate for the previous period, and the percentage difference between the current and previous period order quantities.

The analysis for implementation feature permits the report to be produced without updating the file. The order quantity category codes may be changed between runs of the order quantity program to analyze the effect of changing the code. When the report shows satisfactory results, the program can be rerun to update the item master file with the selected code.

Summary information is provided on the final page of the report for items within each order quantity category code. New and old values are provided for order quantity value, number of orders and order cost. The current on-hand value and on-order value is also shown. A total line shows the sum of each old and new classification for all items in the report.

ORDER QUANTITY REPORT IRP MANUFACTURING CO. 1/26/71 PAGE 1

ITEM NUMBER	DESCRIPTION		ORDER QUANTITY	DOLLAR VALUE	ANNUAL ORDERS	ANNUAL COST	ON HAND	UNIT COST	ANNUAL USE	ICR	OP	CD
A3348	CONTROL BOX		748	2,207	13.4	221	658	2.950	9,999	.200	B	J
		OLD	500	1,475	20.0	330	50 PCT DIFF**			.447		
A3349	CONTROL BOX - PROBE		3,333	5,299	6.0	138	10	1.590	20,000	.052	B	K
		OLD	3,300	5,247	6.1	140	1 PCT DIFF			.053		
A3414	* CLAMP WITH NUT		1,000	70	42.5	531	500	.070	42,500	.200	C	J
		OLD	990	69	42.9	536	1 PCT DIFF					
A3418	RUBBER TUBE - 1 IN.		1,152	300	6.0	132	780	.260	6,800	.876	B	K
		OLD	4,000	1,040	1.7	37	247 PCT DIFF****			.073		
A3425-9	TANK COVER ASSEMBLY		1,000	4,100	6.8	150	600	4.100	6,750	.072	C	K
		OLD	800	3,280	8.4	185	25 PCT DIFF*			.113		
A3444	STANDPIPE		1,000	2,300	6.0	120	800	2.300	6,000	.104	D	K
		OLD	1,600	3,680	3.8	76	60 PCT DIFF**			.041		

ORDER QUANTITY REPORT SUMMARY IRP MANUFACTURING CO. 1/26/71 PAGE 2

CODE	ITEMS	NEW ORDER QTY VALUE	OLD ORDER QTY VALUE	NEW NUMBER OF ORDERS	OLD NUMBER OF ORDERS	NEW COST OF ORDERS	OLD COST OF ORDERS	ON HAND VALUE	ON ORDER VALUE
J	3	3,121	2,350	64	71	836	954	2,015	21
K	6	29,403	34,112	37	30	787	657	5,491	1,457
L	1	360	296	5	6	52	63	32	16
M	1	1,575	1,442	4	4	42	46	7	7
N	1	1,088	1,125	9	9	105	101	150	
OVERALL TOTALS									
	12	35,547	39,325	119	120	1,822	1,821	7,695	1,501

127 ITEMS 13 SELECTED 12 VALID 7 UPDATED

PROJECTION REPORT

The projection report prints a minimum of two lines of information for each selected item based on the selection codes in the parameter record. The first line includes item number and description, alpha factor, current and average demands, first and second average, trend, mean absolute deviation (MAD), and sum of the deviations. This information is printed from the data contained on the item master file for the previous period.

The second line lists the average demand, first and second average, trend, MAD, and sum of the deviations calculated by the program for the current period. The trend and sum of deviations may be positive or negative. This information can be contrasted with the information in the first line.

A third and fourth line are printed for items which contain the proper code in the projection code field and the proper selection code in the parameter record. These lines show projected demand data in shop date and quantity format for the number of periods specified in the program.

The report indicates that the demand filter was tripped for the third item. This means that the demand for this item is outside the range imposed by the program.

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      PROJECTION REPORT                        IERP  MANUFACTURING  COMPANY          1/05/72        PAGE    6

ITEM NUMBER     DESCRIPTION         ALPHA     CUR DEM   AVE DEM   FIRST AVE     SEC AVL       TREND      MAD       SUM DEV

2700006-00      TANK TOP              .10         500     477.0       477.0                               47.7
                MPUPD-25  MPUQD-   11950                  479.3       479.3                               45.2        2.3

2700006-01      TANK TOP              .10         600     613.7       613.7                               61.3
                MPUPD-25  MPUQD-   15330                  612.4       612.4                               56.5        1.3-

2700006-02      TANK TOP              .10          50      33.3        33.3                                3.3
                MPUPD-25  MPUQD-     850   DEM FILTER      34.9        34.9                                4.6        1.6

2700006-20      TANK                  .10          50      45.8        45.8        45.8                    4.5
                MPUPD-25  MPUQD-    1150                   46.6        46.2        45.8                    4.4         .4

 PROJECTED   DATE          1       21       41       61       81      101      121      141      161      181
 DEMAND   QUANTITY        47       47       47       47       47       47       47       47       47       47


2700006-21      TANK                  .10         300     265.8       265.8       265.8                   26.5
                MPUPD-25  MPUQD-    6680                  272.3       269.2       266.1          .3       27.2        3.4

 PROJECTED   DATE          1       21       41       61       81      101      121      141      161      181
 DEMAND   QUANTITY       273      273      273      274      274      274      274      275      275      275
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REQUIREMENTS GENERATION REPORT

The requirements generation report shows the contents of the item master records after the requirements generation program has been executed. The amount of information included in the report can be specified in the parameter record. The print options include or exclude the printing of the indicative information, gross requirements, open orders, net requirements and planned order information. The indicative information consists of unit cost, setup cost, order policy code, order quantity, minimum, maximum, multiple, shrinkage factor, safety factor, allocated quantity, on-hand quantity, and purchase and production lead times.

REQUIREMENTS GENERATION REPORT   I&RP MANUFACTURING COMPANY   1/05/72   PAGE 4

ITEM 2700005-M   PUMPING UNIT

UNIT COST	SETUP COST	ORD.CD.	ORD.QTY.	MINIMUM	MAXIMUM	MULTIPLE	SHRNKF	SAFETY	ALLOCATED	ON HAND	PU/LT	PR/LT
17.300	60.00	A		100			.03	108	800	1,462	15	10

SHOP DATE	1	21	41	61	81	101	121	141	161
GROSS	810	1,193	1,333	1,333	1,283	1,333	1,334	1,342	809
OPEN ORD	860								
NET		633	1,373	1,373	1,321	1,373	1,374	1,382	833
PLAN ORD	633	1,373	1,373	1,321	1,373	1,374	1,382	833	

STOCK STATUS REPORT

On the basis of selection codes specified in the parameter record, the stock status report provides information on the status of selected items. The information provided includes the item number and description; on order, on-hand and allocated quantities; and the sum of issues, receipts and adjustments for the current time period.

STOCK STATUS REPORT   I&RP MANUFACTURING COMPANY   1/05/72   PAGE 1

AN * INDICATES THAT CALCULATED ON-HAND DID NOT MATCH VALUE IN MASTER.

ITEM NUMBER	DESCRIPTION	BEGINV	RECEIPTS	ISSUES	ADJUSTMENTS	ON HAND	ON ORDER	ALLOCATED
A3348	CONTROL BOX	1,499		850		649		600
A3349	CONTROL BOX - PROBE	2,999		1,700	315	1,614	560	
A3414	CLAMP WITH NUT	6,374		3,600		2,774	300	80
A3418	RUBBER TUBE - 1 IN.	1,030		575	315-	140	485	
A3425	TANK COVER ASSEMBLY	2,224		800		1,424	2,150	1,000
A3425-9	TANK COVER ASSEMBLY	1,637		550	75	1,162	862	600
A3444	STANDPIPE	900	100	500	350-	150		
B3418	RUBBER TUBE - 3/4 IN	7,499		4,200		3,299	250	
C3418	RUBBER TUBE - 1/2 IN	7,799	500	4,400		3,899		125
02892	LOCK CLIP	3,058				3,058	200	100
03010	PLATE	918	315	525		708	175	110
03011	THROW-OFF COLLAR	5,182		3,185		1,997	175	
03012	SPRING	13,500		7,500		6,000	100	500
03021	VALVE	1,260	315	750		825	110	
03023	DISCHARGE FERRULE	4,750	100	2,650		2,200	125	
03024	SHELL	1,978		1,100		878		400

GLOSSARY

ABC Classification. Classification of items in inventory based on annual dollar volume. Class A items have the highest annual dollar volume and subsequent letters are used to separate the inventory into as many lower classes as are desired.

ABC Inventory Control. A system of inventory control that applies different methods of control to items in different value classes.

Allocated Material. Material which is assigned to specific production orders (reserved material).

Assembly. A group of parts or subassemblies that are assembled to make a more complex item.

Available for Net. Material available for planning. This is composed of on-hand inventory plus on-order inventory but excludes all allocated inventory.

Carrying Cost. Cost of carrying inventory, usually a percentage of the value of the item per unit of time.

Cycle Stock. That portion of inventory that depletes and is replenished by an order. The average amount of inventory excluding safety stock.

Demand. The desire to purchase a commodity as reflected by orders.

Economic Order Quantity. The quantity of an item which should be ordered at one time to minimize the total cost.

Forecast. The prediction of future data based on past data.

Gross Requirements. The total requirement for an item, exclusive of any on-hand stock or other inventory.

Inventory. Items that are treated as units and stored at a common point.

Lead Time. The number of days required for an order or item to be fabricated, assembled or purchased.

Manufacturing Order. An order to the production facility for specified parts or assemblies.

Net Requirement. The actual requirement for a component. Gross requirements less on-hand stock plus on order.

On Hand. The balance shown in the inventory record.

On Order. The total of all outstanding replenishment orders.

Open Order. An order that is in the process of being issued to the shop floor or vendor or that is partially complete. It represents a firm commitment for an order expected to be received in inventory at some future date.

Order Point. That level of inventory which will cause an order to be placed.

Planning Horizon. The time range for which requirements planning is to occur.

Planned Order. An order reflecting future tiem requirements after deduction of inventory and open orders.

Purchase Order. An order to a vendor for specified parts or materials.

Projection. (See "forecast".)

Release Cycle. The time required to prepare the necessary documents and withdraw material from inventory before a production order can begin.

Safety Stock. A portion of the inventory set aside to cover the uncertainty in demand.

Shop Calendar. A dating technique that eliminates non-work days and numbers the remaining days, typically, from 000 to 999, thus giving 1000 consecutive work days (about four calendar years).

Shrinkage Factor. A factor applied to an order requirements to reflect spoilage during production or rejection if purchased. The shrinkage factor is not used when a gross requirement is covered by inventory.

Time Period. The segment of time (day, week, month) which is used in planning.

BIBLIOGRAPHY

Brown R.G., Smoothing, Forecasting and Prediction of Discrete Time Series, Prentice-Hall, Englewood Cliffs, New Jersey, 1963.

Magee, John F., Production Planning and Inventory Control., McGraw-Hill, New York, 1958.

IBM Publications

Basic Principles of Wholesale IMPACT - Inventory Management Program and Control Techniques (GE20-8105)

Wholesale IMPACT - Advanced Principles and Implementation, Reference Manual (GE20-0174)

Management Operating System, Inventory Management and Materials Planning Detail (GE20-0050)

Management Operating System for Manufacturing Industries, General Information Manual (GE20-8041)

Production Information and Control System (GE20-0280)

System/3 Bill of Material Processor, Application Description Manual (GH20-0965)

System/360 Inventory Control, Application Description Manual (GH20-0471)

System/360 Requirements Planning, Application Description Manual (GH20-0487)

READER'S COMMENT FORM

S/3 Inventory and Requirements Planning
Application Description Manual

GH20-0971-2

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