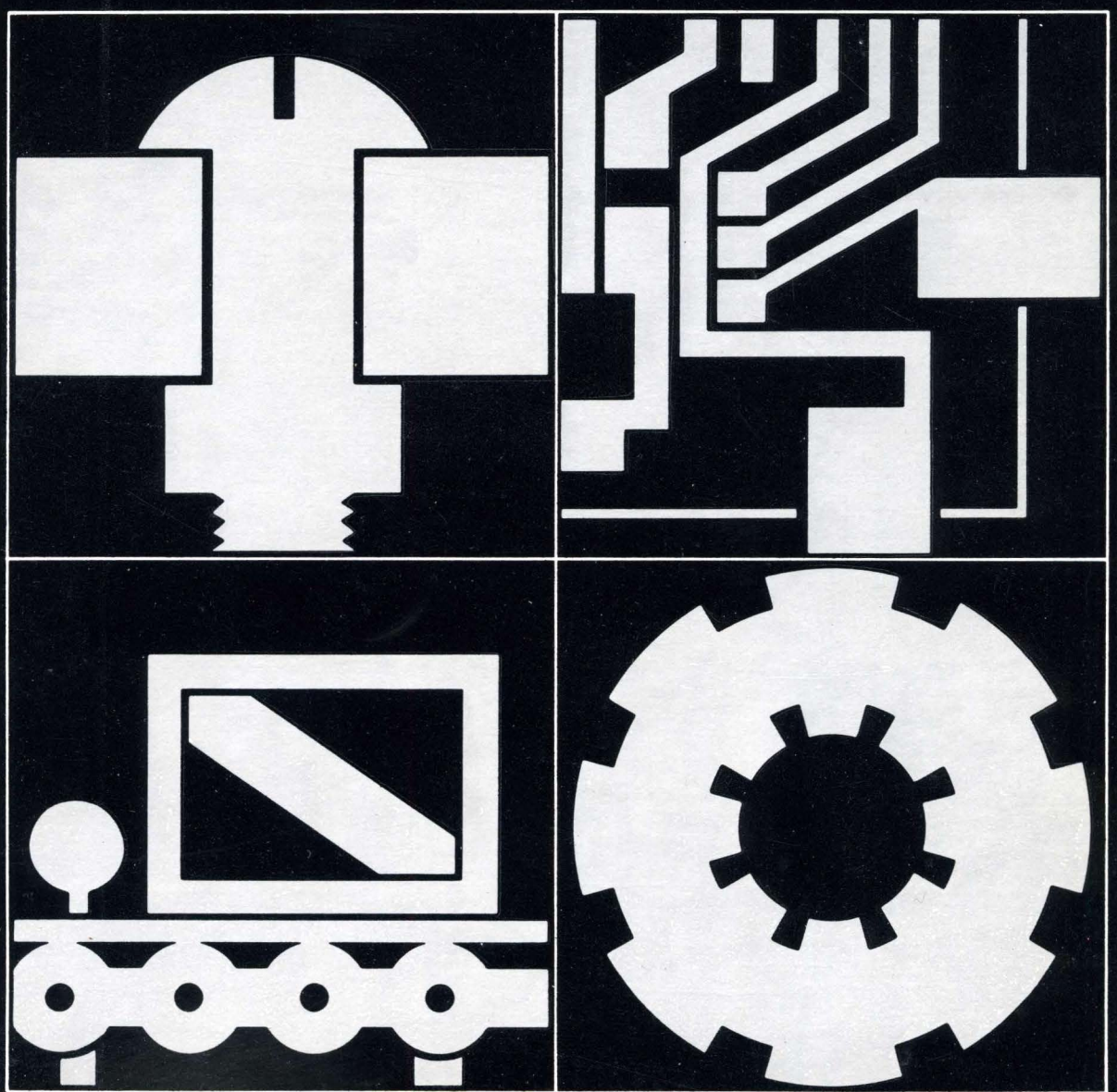
IBM

Communications Oriented Production Information and Control System

Volume VII

Chapter 10 Purchasing and Receiving
Chapter 11 Stores Control
Chapter 12 Cost Planning and Control



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Chapter 10 Purchasing and Receiving
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First Edition (March 1972)

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Foreword

COPICS (Communications Oriented Production Information and Control System) is a series of concepts that outline an approach to an integrated computer-based manufacturing control system. The concepts deal with problems common to most companies, from a forecast of customer orders, through development of the master production schedule, to production and shipment of the product. COPICS is involved, therefore, with allocation and control of most of the major resources of a company – plant, equipment, manpower, and materials.

COPICS evolved from the approach to manufacturing applications presented in the IBM publication *The Production Information and Control System* (GE20-0280). In COPICS those applications are defined from a communications point of view and have been expanded in scope.

The twelve COPICS chapters provide management with a guide for development of a dynamic online manufacturing control system that is terminal and communications oriented and event responsive. The chapters present the system's concepts in a manner designed to help develop a system that can truly respond to the requirements of all levels of operating personnel and management. Little knowledge of computers is assumed, although some prior exposure to computer concepts and familiarity with such terms as "program", "files", etc., is helpful. Emphasis is on what the problems are and *why* their solution is valuable. How specific problems are solved is discussed only at that level of detail required to assure managers that the solution is feasible. The computer is not, itself, the system, but is, rather, a tool to be used by the manager.

The COPICS concepts are oriented to production and related manufacturing applications. They are not concerned directly with other major areas, such as finance, marketing, and personnel, although the COPICS approach collects data that will be helpful to these areas.

Throughout the COPICS publications, distinction is made between a given COPICS concept, the corresponding chapter, and the corresponding plant department by the use of small capital letters, italics, and initial capital letters, respectively. For example, reference may be made to the COPICS concept PURCHASING AND RECEIVING, or to material in *Chapter 10, Purchasing and Receiving*, or to the plant departments called Purchasing and Receiving.

The complete system is presented in eight volumes containing, in all, 17 sections. The Management Overview section is also available as a separate publication, G320-1230. The contents and IBM order numbers of the eight volumes are as follows:

Volume I	G320-1974	Management Overview, System Requirements, Index, Glossary
Volume II	G320-1975	Chapter 1 Engineering and Production Data Control
		Chapter 2 Customer Order Servicing
Volume III	G320-1976	Chapter 3 Forecasting
		Chapter 4 Master Production Schedule Planning
Volume IV	G320-1977	Chapter 5 Inventory Management
Volume V	G320-1978	Chapter 6 Manufacturing Activity Planning
		Chapter 7 Order Release
Volume VI	G320-1979	Chapter 8 Plant Monitoring and Control
		Chapter 9 Plant Maintenance
Volume VII	G320-1980	Chapter 10 Purchasing and Receiving
		Chapter 11 Stores Control
		Chapter 12 Cost Planning and Control
Volume VIII	G320-1981	System Data Base

To obtain the complete set of eight volumes please order the IBM Bill of Forms number GBOF-4115.

Chapter 10. Purchasing and Receiving

Contents

In many manufacturing companies, Purchasing and Receiving do not receive the attention they deserve, because management tends to concentrate on the more apparent complexities of planning and controlling production. Yet many production problems are created by late deliveries from suppliers and by rejection of critical deliveries because of poor quality.

The design of PURCHASING AND RECEIVING helps ensure that the right quantity and quality of material is available when it is needed. Improved methods of evaluating supplier performance reduce shortages and the possibility of accepting off-standard material.

One of the system's major benefits is better use of the buyer's time. The semiclerical activities that often consume much of his time – searching for a copy of an order, trying to discover whether a delivery was received, etc. – are reduced or eliminated. The buyer thus spends more time seeking a better price while maintaining reliable sources of supply.

Expenditures on purchased materials and services in manufacturing companies can account for 30% to 60% or more of sales. A small reduction in the cost of this material can markedly affect profits. When profits are squeezed by rising costs and competition, the effect is magnified. Figure 1 shows that when profits are only 8% of sales, a small reduction in the price of purchased material can yield an increase in profit of 12%.

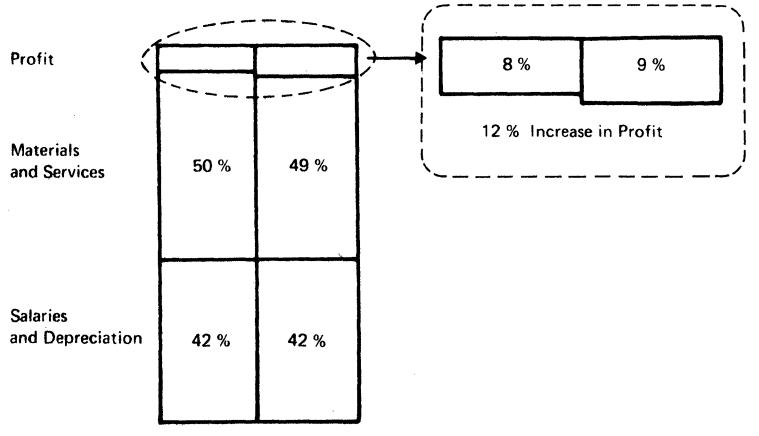


Figure 1. A small reduction in the cost of purchased materials has a significant impact on profits

All-out attempts to reduce purchase prices, however, may not serve the company's long-term interests. For example, a reduced purchase price may result in lowered standards of quality or an inadequate profit for the supplier. Both situations are unstable: the purchaser may seek a higher-quality supplier, probably at the original price, or the supplier will seek higher-profit customers.

PURCHASING AND RECEIVING helps avoid this situation by providing more *useful* buying time while developing and monitoring supplier standards for delivery and quality. It distinguishes suppliers whose performance is improving from those whose performance is falling, and it protects both buyer and seller by controlling the planned load placed on suppliers' resources.

Relationship with other application areas

This chapter is divided into three major sections:

- *Purchasing,* concerned with supplier selection and order placement and follow-up activities
- *Receiving,* which addresses the identification and validation of a receipt and the routing of the material through counting and inspection to stores or direct to the work area requiring it
- *Purchase Quality Control,* involving inspection and acceptance of the order, control of rejected material, and supplier quality evaluation

The relationship of these areas with other application areas is shown in Figure 2.

PURCHASING AND RECEIVING is an execution system rather than a planning system. The output of MATERIAL REQUIREMENTS PLANNING is a planned order, which in the case of purchased material becomes a supplier release or a material requisition at time of order release. In addition, requisitions for such items as services, supplies, and maintenance parts originate outside the mainline production planning system.

Purchasing negotiates price, quality, and delivery conditions and selects a supply source. Much of this activity precedes generation of the requisition, and approval consists of merely acknowledging the effect of previous purchasing decisions. As a result of this activity, the material requisition becomes a purchase order, or, in the case of a blanket order, a supplier release.

Receipts are identified and verified through data established and maintained in PURCHASING. Order status information is immediately updated and made available to INVENTORY MANAGEMENT for planning inventory availability and to COST PLANNING AND CONTROL for projecting cash commitments.

The order is routed on the basis of information supplied by PURCHASE QUALITY CONTROL and by PLANT MONITORING AND CONTROL. Progress of the receipt is traced through Counting and Inspection until it is received and stored by STORES CONTROL. Urgently required material is routed directly to the present production location of the shop order as maintained by PLANT MONITORING AND CONTROL.

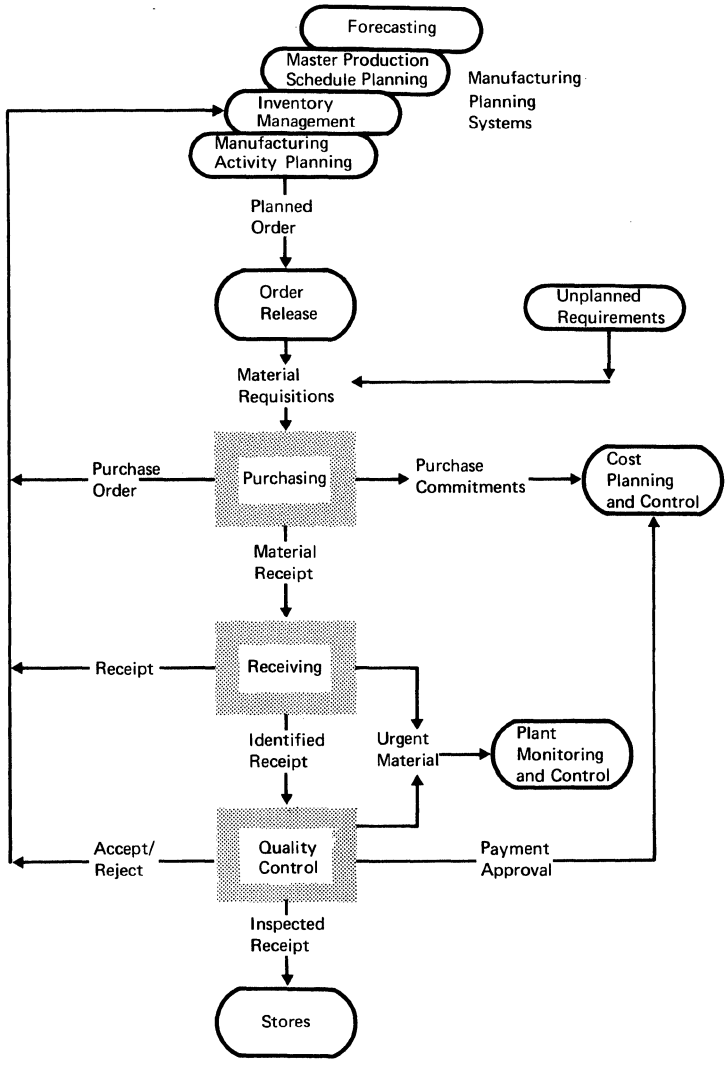


Figure 2. The relationship of PURCHASING AND RECEIVING with other application areas

Purchasing

The objectives of purchasing are to obtain the required quantity of material by the date specified, at the lowest possible price consistent with the required quality level. To do this, Purchasing must have time to evaluate an adequate number of suppliers for each item. For important items, current price and delivery quotations must be secured from several sources of supply. Care must be taken not to overload any one supplier, thereby jeopardizing on-time delivery.

Although price is important, so is the ability of the supplier to deliver within a short lead time. The requirement to place orders far in advance can result in higher inventory. Therefore, negotiating for shorter delivery lead time is also an important buyer function.

Purchase orders must be followed up to avoid late delivery and consequent upsets to the manufacturing plan. A supplier capability to deliver on time must be evaluated, and delivery variations must be allowed for in planning.

Delivery of off-standard material can significantly disrupt manufacturing planning and execution. Therefore, the quality of each receipt must be measured against standards. Historical comparisons must be maintained to allow buyers to negotiate better performance from suppliers whose quality rating is drifting.

These objectives are interrelated; one supplier's low price may be offset by less consistent or longer lead time, or by lower overall quality. Therefore, the factors must be weighed against each other. To do this, Purchasing must maintain data on what items the supplier can furnish, his available capacity, and his historical price and delivery performance.

The techniques presented here allow more effective evaluation and selection of suppliers and reduce the clerical effort that consumes most of a buyer's time, thus freeing him for negotiation with suppliers.

Functions of Purchasing

Figure 3 indicates the phases of purchasing and associated activities.

pre-order activities

Creating supplier and quotation data includes the review of possible suppliers and the recording of data describing their capabilities (types of item manufactured, available capacity, etc.). It also includes obtaining and approving enough quotations for each purchased item.

Supplier evaluation includes recording and ranking individual suppliers' performance, on the basis of price, on-time delivery, and adherence to quality standards. This evaluation assists in supplier selection.

order placement activities

Requisition entry and control involves automatic creation of requisitions from planned orders generated by INVENTORY MANAGEMENT, as well as terminal entry of unplanned requirements for services and one-time purchases.

Supplier selection provides a recommended supplier at the time of order placement, based on the current supplier ratings.

Requisition completion and approval includes the approval of all orders and the control of emergency orders.

Purchase order generation includes automatic generation of purchase orders and release of blanket orders to suppliers.

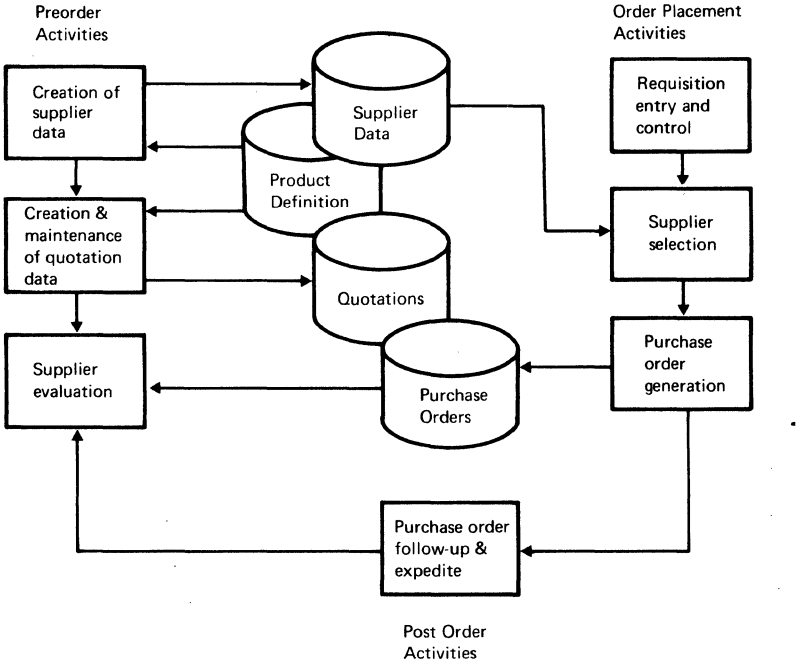


Figure 3. Purchasing functions

post-order activities

Purchase order follow-up and confirmation includes control of order acknowledgments, requests for confirmation of delivery dates, and procedures for implementing and controlling changes to orders after they are placed.

Purchasing department planning uses the information available from purchasing operations to measure buyer workload. The planning of purchasing commitments is also included.

Creating Supplier and Quotation Data

The basic information needed to place an order is kept in the purchasing data base. It includes:

- *Supplier data,* which indicates approved supplier for each item
- *Quotation data,* which indicates the current prices and delivery lead times of all approved suppliers for the item

In conjunction with supplier performance data, this data forms a basis for supplier selection. The following discussion describes approving suppliers and obtaining and maintaining quotations.

Potential supplier analysis

Approval of a supplier involves two stages:

- *Supplier approval.* This is acceptance as a potential supplier for a class of items, and results from a satisfactory examination of the supplier's quality standards, price levels, production capacity, and production control system.
- *Supplier certification.* This is acceptance as a potential supplier for a specific item, after receipt of a satisfactory quotation.

supplier approval

Approval is usually made through discussions between the buyer and the potential supplier. It commonly involves visits to the supplier's production facilities for inspection of quality control procedures, production control systems, and production capability.

Approval results in the creation of a record in the supplier data. Examples of the data held in the supplier record are shown in Figure 4. Approval denotes that the supplier may be requested to quote for specific types of item. These types are indicated by:

- The commodity code or codes placed in the supplier record. These distinguish groups of items the supplier can provide, based on the types of production facilities he maintains – say, light machining, die casting, or plating and polishing.
- The total capacity that can be made available for each type of facility.

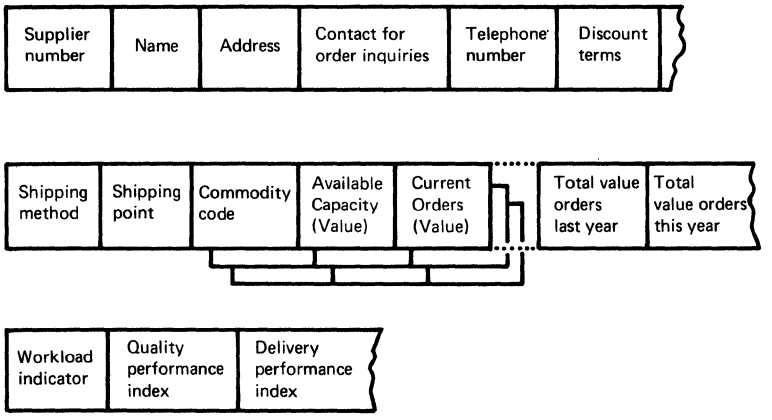


Figure 4. Basic supplier data

The supplier record can now be used when the buyer requests quotations for a new item, or additional quotations for an existing item.

supplier certification

When a quotation for an item is first accepted from a supplier, he becomes an approved supplier for that item. He is notified and a quotation record is created (see "Accepting Quotations"). The quotation record is connected to the supplier record, and to the record for the item (Figure 5). This allows fast retrieval, via a terminal inquiry, of such information as:

- All open quotations for a particular item (Figure 6)
- All open quotations from a particular supplier

Obtaining quotations

Quotations must be obtained when new items are required, when quotations for existing items reach their expiry date, and when new or additional suppliers are required for an existing item. Quotation requests may be sent to existing as well as approved suppliers for the item, and the system maintains control over the outstanding requests until the quotations are received and either accepted or rejected.

request for quotation

A request for a quotation can be initiated automatically by the system, or manually by the buyer. The system initiates a quotation request by placing a notification in the appropriate Buyer's Action File. He can review the system-generated request and release it for printing and forwarding to the supplier, or he can modify or withhold it, depending on the current supplier rating and the number of alternative quotations available for the item.

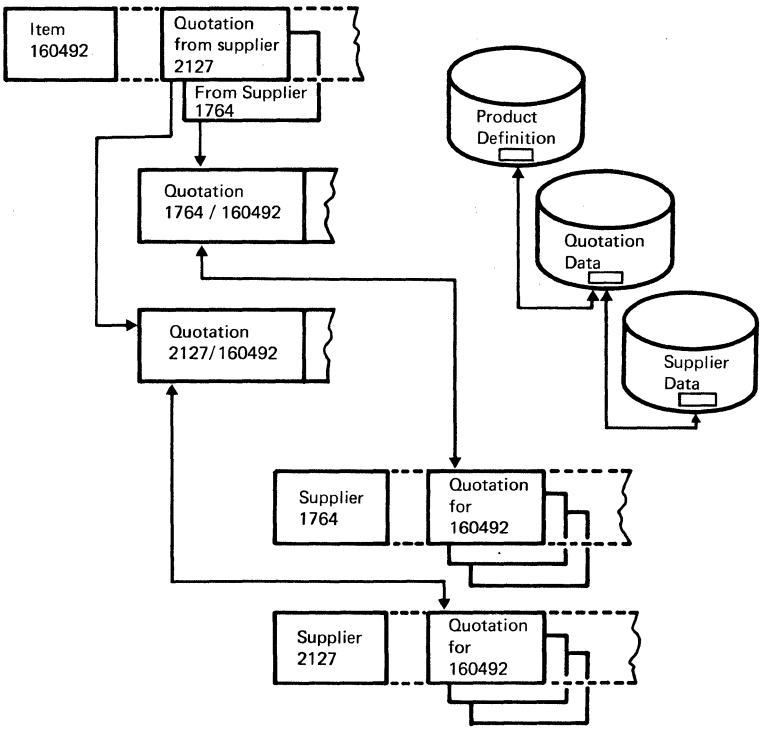


Figure 5. Suppliers for an item are available from the item record

```
ITEM          DESCRIPTION          ENG.CHANGE
 NO.                                 LEVEL
-----------------------------------------
172901        NEEDLE VALVE         E49171

                                                                    -EMERGENCY-
SUPPLIER    QUOTE    VALID     MIN     PRICE    UNIT OF     LEAD     MIN    LEAD    PRICE
  NO.         NO.     TILL     QTY              MEASURE     TIME     QTY    TIME
-------------------------------------------------------------------------------------

20742       97931     243        1    4.20       EACH        6       1       3    4.50
                               100    4.00       EACH        6
                               500    3.80       EACH        6

21329       20413     260       50    4.00       EACH        7

34001       64117     260       10    4.10       EACH        5      10       2    5.00
                              100    3.80       EACH        6     100       3    4.50
                             1000    3.50       EACH        6
```

Figure 6. The buyer can display all current quotations for an item

When a quotation is allowed to expire, the supplier is no longer approved for the item concerned.

Requests for replacement of expiring quotations are automatically placed in the Buyer's Action File in time to obtain a new quotation before the current one expires. Consequently, current quotations are always available. The request for a new quotation is created during a periodic review of the quotation file, using the date of the last quotation and the quotation validity (Figure 7).

Items purchased infrequently may generate a large volume of unnecessary quotation requests if handled in this way. A quotation in the item record identifies these items, and quotations for them are renewed only when required. In this case the system generates a request for a quotation only if the previous quotation has expired, and if a planned order exists. The system considers normal purchasing lead time plus the time needed to obtain a new quotation when generating a request.

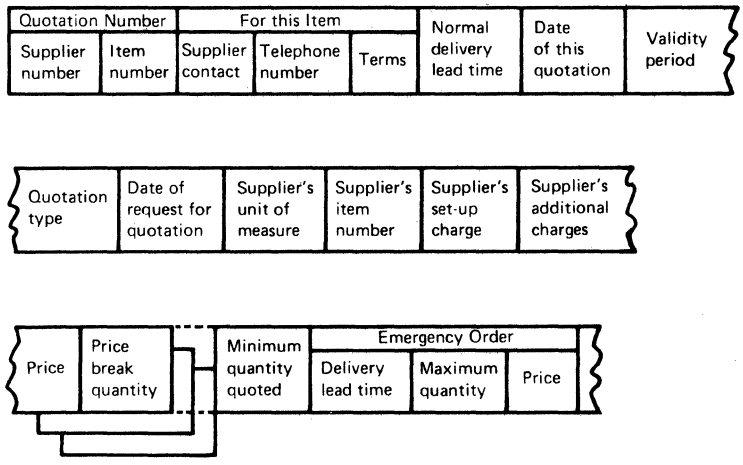


Figure 7. Example of data maintained in the quotation record

Quotations from new suppliers can also be requested on the buyer's initiative. This may be done when an initial quotation is required from either a new or existing supplier for an item he has not previously supplied.

The item commodity code identifies the supplier characteristics required, and the system searches the supplier data for suppliers approved for that commodity code. The system displays the selected suppliers along with a composite performance rating on all items supplied by them (Figure 8). The buyer selects the suppliers from

whom he will request quotations. He then indicates them to the system, which then automatically prints a quotation request for each of the selected suppliers and creates a control record to indicate that a quotation request is outstanding.

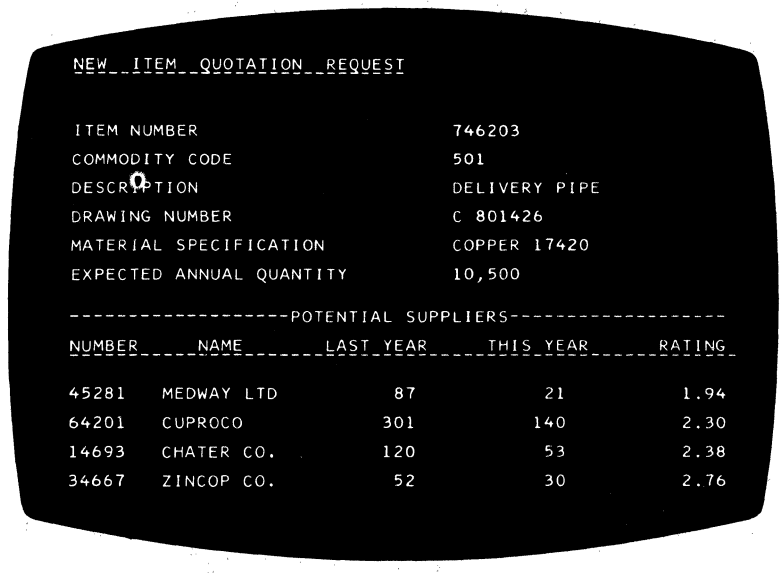


Figure 8. Approved suppliers for an item type are displayed. The buyer decides which ones should receive a request to quote

Quotation requests for new items are initiated automatically through the procedure for staged entry of new item data described in *Chapter 1, Engineering and Production Data Control.* In this procedure, data required when the item record is first created is identified by the system, and the departments responsible for supplying specific information are automatically informed. For example, for new purchased items the delivery lead time and the standard cost must be supplied by Purchasing. The demand for this information automatically creates a request for quotation, which is then placed in the appropriate Buyer's Action File.

quotation request control

The system reviews the quotation file periodically, say weekly, to identify all quotation requests outstanding for longer than a predetermined period. This period can vary from one commodity type to another to reflect the different amounts of work the supplier must perform in preparing a quotation.

Overdue requests are placed in the Buyer's Action File. After he has reviewed them, a reminder is automatically generated for the supplier.

Accepting quotations

When quotations are received, they pass through an initial review and then enter into the system, where they are stored as temporary quotation records. They then appear in the Buyer's Action File to be reviewed for possible acceptance.

Quotation entry is performed by entering the details of the supplier's quotation in a quotation "form" displayed on the screen of a terminal. The content of the quotation is immediately checked against the quotation request. If it is complete, it is entered into the system, and a notification is placed in the Buyer's Action File.

Acceptance or rejection of the quotation is determined by the buyer. He can display the quotation and, for comparison, all other quotations for the item. After review he enters an "accept" or "reject" indication at the terminal. The accept indication removes the temporary indicator from the quotation record, which then becomes available for selection during order placement. An acceptance notification is printed automatically for the supplier. The reject indication causes the quotation record to be removed from the file.

If the quotation is for a new item, the buyer may wish to delay the decision to accept or reject it until further quotations are available. To do this he leaves the item in his work queue until the remaining quotations also appear there.

In accepting a quotation, the buyer also indicates whether the new quotation is to become effective immediately or when the existing quotation expires.

Supplier Evaluation

An objective evaluation of supplier performance is continuously maintained by the system. The ratings are updated on completion of each receipt. Consequently, up-to-date supplier ratings are generally available prior to order placement and serve as a basis for supplier selection. The objective of supplier evaluation is to provide a common basis on which to compare suppliers' recent performance and their current price for an item. The factors used in evaluation are:

- *Quality.* PURCHASE QUALITY CONTROL provides Purchasing with the number of rejects. This is retained in the supplier record. The index for quality measurement is usually the reject percentage, a weighted moving average which is automatically maintained by the system (see "Forecast Maintenance via Exponential Smoothing" in *Chapter 3, Forecasting*). This method allows more importance to be given to performance on recent orders.

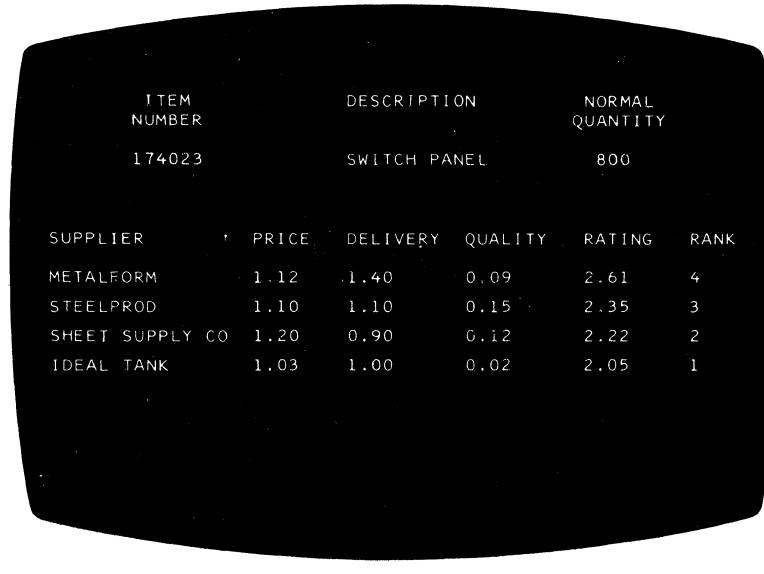
- *Delivery.* At order completion, the system calculates the percentage of standard lead time taken to deliver. At the same time, the existence of insufficient lead time (as when the item was ordered too late) can be recorded as a guide to the performance of the order planning and purchasing systems.
- *Price.* The quoted price is expressed as a percentage of the current base standard cost for the item. This cost is defined in *Chapter 12, Cost Planning and Control.* If the price varies with order size, the price for the normal order quantity is used to develop the price index.

combining evaluation factors

The individual indices for quality, delivery, and price are maintained as averages, using exponential smoothing (see *Chapter 3, Forecasting*). This method enables management to give more importance to recent orders.

Quality and delivery ratings are updated on completion of each order. Price, however, may change before the next order is placed, so evaluation of price performance is delayed until supplier selection, immediately before the purchase order is generated.

Figure 9 shows a terminal display of the current supplier ratings for a specific item, with the ranking of the individual suppliers. An equal weight has been given to each factor. For example, deliveries taking 10% longer than the standard lead time would have the same effect as 10% of items rejected by Purchase Quality Control. Since this level of rejects would, in practice, be regarded as more serious than the lead time deviation, weighting factors may be applied at the time the indices



ITEM NUMBER	DESCRIPTION	NORMAL QUANTITY
174023	SWITCH PANEL	800

SUPPLIER	PRICE	DELIVERY	QUALITY	RATING	RANK
METALFORM	1.12	1.40	0.09	2.61	4
STEELPROD	1.10	1.10	0.15	2.35	3
SHEET SUPPLY CO	1.20	0.90	0.12	2.22	2
IDEAL TANK	1.03	1.00	0.02	2.05	1

Figure 9. Supplier ratings for price, delivery, and quality

are combined. The weighting factors can be supplied to the system by Purchasing management and may be varied for individual items or commodity codes.

Requisition Entry and Control

The system automatically generates requisitions when planned orders are released. Requisitions for many planned items can be edited by the system, and proceed through purchase order generation automatically without buyer review (see "Purchase Order Generation"). In addition to these, requisitions are created manually for items not subject to planning and control techniques in INVENTORY MANAGEMENT. Examples may include services and items infrequently purchased for maintenance or engineering.

Requisitions originating in Inventory Management

For items subject to the replenishment techniques in INVENTORY MANAGEMENT, the release of purchase requisitions is accomplished automatically on the basis of the planned order release date. On this date, ORDER RELEASE triggers the creation of the purchase requisitions by placing a request for purchase order release in the appropriate Buyer's Action File. Figure 10 shows the basic content of a requisition.

PRIORITY	REQUISITION NUMBER	ITEM NUMBER	ITEM NAME	DATE REQUIRED	RECOMMENDED QUANTITY	SUPPLIER	PRICE	SUPPLIER NAME	PURCHASE LEAD TIME
10	104162	199216	VALVE	196	2000	76224	1.14	SMITH CO.	25

Figure 10. Display of purchase requisition data

The date required and the recommended purchase quantity are a result of decisions made in INVENTORY MANAGEMENT. The recommended supplier, his price, and normal lead time result from decisions discussed later, under "Supplier Selection". If necessary, additional detail regarding both the recommended supplier and other quotations can be displayed via terminal inquiry.

This basic requisition data is placed in the Buyer's Action File in priority sequence.

Creating requisitions for unplanned items

Requisitions for services and other items not planned by Inventory Management are usually entered from a written requisition. The information on the requisition is essentially the same as that originating from ORDER RELEASE.

The data from the written requisition can be entered using a terminal located in the purchasing department. During entry the requisition can be edited for reasonableness and completeness. At this stage supplier and account numbers are also added. From this point on, the requisition can be handled in a manner quite similar to that of normal production material. Temporary item records are set up to facilitate control by the same procedures established for frequent purchases.

A large proportion of the demand for unplanned items is normally created by a small number of departments, such as Plant Maintenance or Design Engineering. In these cases terminals may be installed in the department to permit direct entry of purchase requisitions. The requisition is placed immediately in the Buyer's Action File (Figure 11), reducing paperwork, lead time, and the possibility of lost or delayed orders. If the requisition has a high priority, it can be processed as soon as it is entered.

Requisition control

The buyer has complete freedom in selecting which requisitions he wishes to work on. He uses the priority sequence maintained by the system as a guide. He may elect to work on requisitions out of sequence because:

- He wishes to handle all requisitions from one supplier at one time.
- All quotations have not been received.
- Information for unplanned orders or new items is incomplete.

The buyer places in the requisition record a reason code explaining why the requisition has not been released. The system periodically reviews outstanding requisitions and compiles delay summaries for planning and control purposes. These summaries can be organized by number of days outstanding and reason for delay (Figure 12).

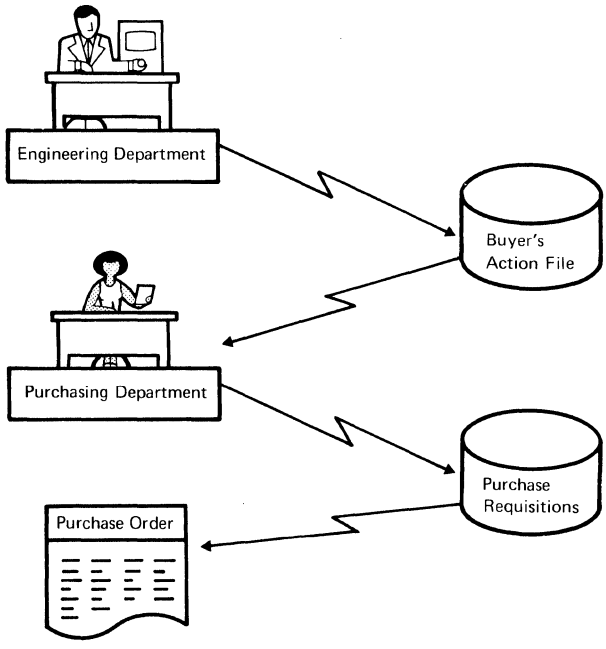


Figure 11. Direct entry of requisitions by requesting departments

BUYER NO. 32 — NAME: A. REICHERT — PRIORITY: 1X, 2X — TOTAL REQ: 20, 33

LINE NO.	REQ.NO.	PART NO.	NAME	REQ. TYPE	PRIORITY	QTY.	SUPPLIER	REASON
01	10614	422616	MOTOR	A	11	250	0479	NO PRINT
02	10688	994225	MOTOR	A	10	360	2032	PEND QUOTE
03	10587	556620	BRUSH	C	10	1500	1171	PEND QUOTE

Figure 12. Control reports are maintained to help ensure that requisitions are not held up unnecessarily

Supplier Selection

The principal basis for supplier recommendation is a composite rating system. This takes into account the supplier's historical performance regarding delivery and quality, as well as his current price quotation.

At the time the requisition is generated, the system selects the supplier with the highest rating. Care must be taken not to use minor differences in supplier rating as a reason for exclusion. Because of the weighting used in averaging and combining the factors, the rating is still largely subjective. The system can therefore be instructed to display all suppliers falling within a certain range of the highest rating. Final selection is then left to the buyer.

System-generated supplier selection has several advantages:

- It enables many orders to be generated automatically and reduces or eliminates buyer time spent on low-value orders.
- Personal bias is minimized, the rating and selection being made mainly on measurable factors.
- It may be company policy not to become too dependent on a single supplier. The system can automatically identify and control items that must be divided between two or more suppliers.
- It is completely up to date, since it includes the most recently completed orders in the measurement of performance.

Another factor that can be considered in supplier selection is *supplier workload.* When using a significant proportion of a supplier's capacity, a purchaser must avoid overloading that supplier's production facilities. Supplier workload may have to be considered also because:

- There may be an agreement between supplier and customer that a fixed percentage of capacity will always be available, and it is to be utilized if possible.
- A supplier who performs well may, because of a high rating, receive too many orders and ultimately experience difficulties in maintaining delivery promises.

Supplier workload monitoring can be varied according to the supplier's production facilities and the mix of items purchased from him. For example:

- A supplier of small die-castings may be monitored through the money value of total purchases outstanding, since this is a good measure of his total production load.
- A supplier who provides, say, both heavy and light machining facilities may be monitored by the total money value of purchases in each of these categories, using separate capacity values for the facilities.
- A supplier who provides a large volume of high-cost items, involving specialized equipment, may call for detailed planning, on the basis of total hours of load imposed on specific facilities.

Basically workload monitoring involves placing a workload indicator in the supplier data. When this is recognized during supplier selection, the commodity code of the item to be purchased is matched against those in the supplier record. The appropriate value of orders outstanding is then increased by the value of the order being placed and is included in the display to the buyer.

When workload monitoring is used, the buyer uses the performance rating and the displayed workloads together to select the supplier.

Requisition Completion and Approval

Most requisitions generated by ORDER RELEASE can be processed with minimal buyer intervention. Orders for low-value items can be generated automatically by the system and released without action by the buyer. Purchasing has complete control over which items can be treated in this manner.

For other items, requisitions are put onto the Buyer's Action File in priority sequence. In reviewing these requisitions, the buyer may accept the system's recommendations, in which case the documentation will be automatically generated and dispatched. In other cases the buyer may need to alter or add information before release. This is done via terminal entry (Figure 13).

A requisition with a system-recommended supplier is displayed to the buyer. The current date is 160. Because the system has selected a supplier with a short lead time, the placing of the order can be delayed by up to 20 days.

The buyer enters a reason code to show why processing of the requisition has not been completed. "E" indicates that the requisition was reviewed earlier than necessary. He also enters the delay time (10) after which he will again review the requisition. Until then it will remain in the work file with the lowest priority.

Figure 13. The buyer may use a terminal to alter recommendations made by the system

altering requisitions for production material

The recommendations made by the system are based on decision logic originally provided by inventory management, the buyer, and purchasing management. However, there are several reasons why the buyer may wish to override the recommendation. For example:

- The lot-sizing decision may be based on the average price of all approved quotations. If price or acquisition costs vary significantly among suppliers, the buyer may ask that the economical order quantity be recalculated for a specific price or acquisition cost.
- Order release has to be based on the longest lead time of approved quotations. If a supplier with a shorter lead time is selected, the buyer should alter the requisition release date. He does this by placing a code indicating deferred purchase order release and by specifying the particular supplier chosen. No further review will be necessary unless INVENTORY MANAGEMENT generates last minute changes to planned orders. Since such changes usually involve only minor quantity changes, subsequent review time is minimal.

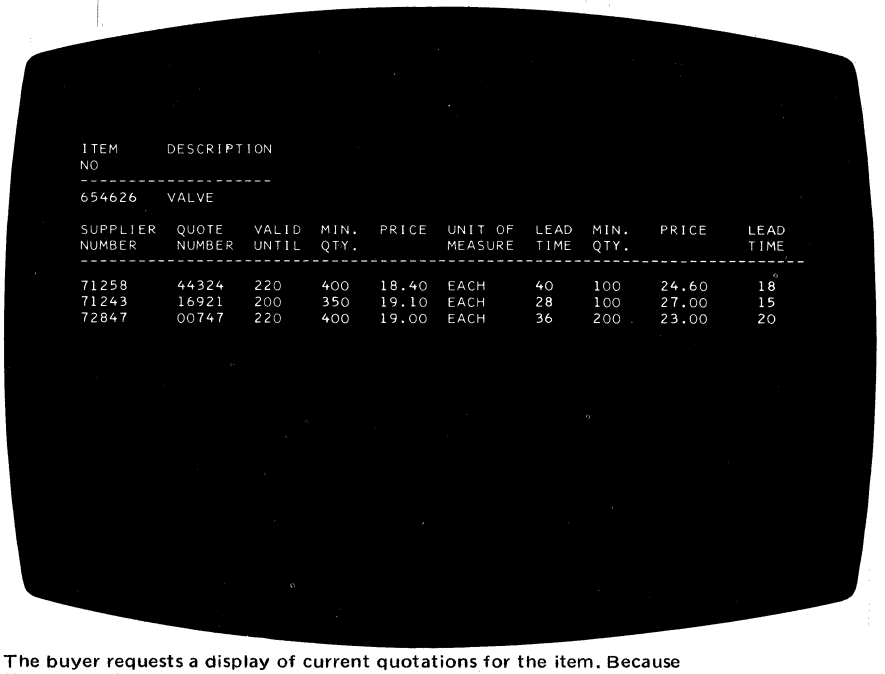
- If the buyer is aware of potential problems at the recommended supplier's plant, he may wish to bypass this supplier temporarily.
- If approximately equal ratings make it difficult to decide which supplier is best, the buyer may wish to make sure the business is equitably spread among qualified suppliers.
- Special purchasing opportunities, possibly caused by overproduction at a supplier's plant, may make larger purchases advisable. The system can immediately recalculate a recommended order size on the basis of the one-time price and display the results on a terminal.

In all cases the buyer has complete freedom to override the quantity and supplier recommendations that were based on previously produced decision rules. These changes are entered via terminal from the purchasing department.

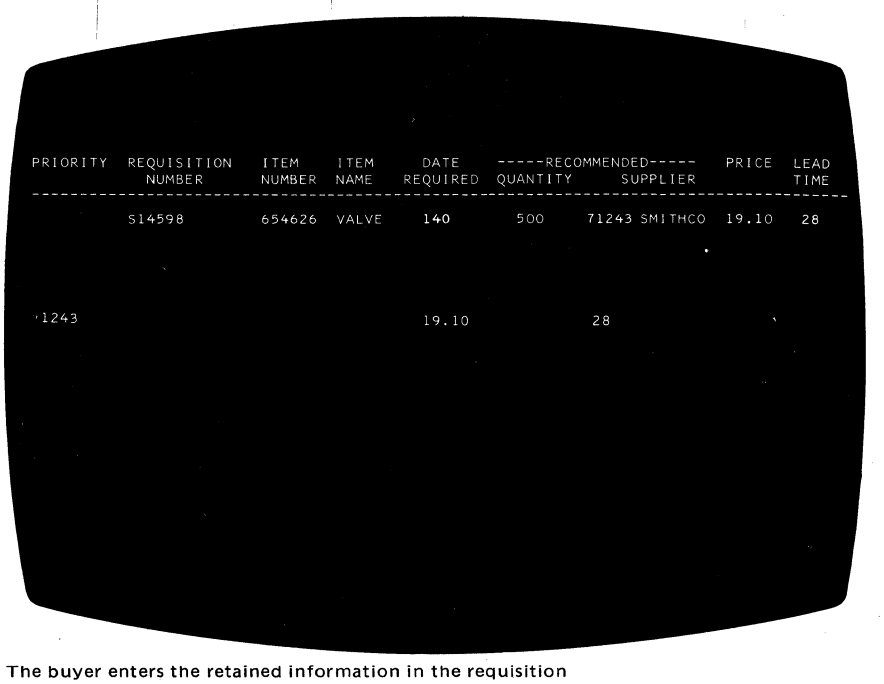
Before altering a recommendation, the buyer may need more detail concerning alternate suppliers, other outstanding quotations, and inventory status and planning information. All this is immediately available via terminal inquiry (Figure 14). However, if he attempts to change a due date or lower the recommended quantity to a point that will cause a material shortage, the inventory administrator is automatically notified via his Action File. Purchase quantity increases which are not covered by future needs or which will extend beyond a planned engineering change are also detected by the system and indicated to the buyer and the inventory administrator.

The buyer reviewing this requisition knows that the system-recommended supplier is experiencing production difficulties. Current orders have been adjusted and he decides to divert new orders to other suppliers until the problems have been overcome.

Figure 14. Additional data needed to make purchasing decisions can be obtained quickly via a terminal inquiry (sheet 1 of 2)



The buyer requests a display of current quotations for the item. Because the production problems of the supplier selected by the system may result in heavier workloads for the other valve manufacturers, he selects the supplier with the shortest lead time. He indicates the information that he wishes to retain, and recalls the requisition.



The buyer enters the retained information in the requisition and releases it for purchase order generation.

Figure 14. Additional data needed to make purchasing decisions can be obtained quickly via a terminal inquiry (sheet 2 of 2)

Controlling emergency orders

Emergency orders are often initiated by a telephone call with a request for an order number. Although their volume is usually small, they are often difficult to control.

The buyer obtains the identification (department name or account) of the requester, and the requisition number. He then obtains a system-assigned order number by creating a temporary order record, which includes the requisition number and originator's identification.

When the originator provides the details needed to complete the record, the buyer obtains the record (by its order number), enters the missing information, and deletes the temporary status. If the temporary status remains in the record for longer than a predetermined time, a notice is automatically placed in the Buyer's Action File.

Approving blanket orders

Blanket orders (running orders) are usually contracted to obtain lower prices based on some estimate of an annual volume promised to the supplier. There is little difference to the system between normal purchase orders and blanket orders.

However, because of long purchasing lead times and the need to help the supplier in his planning, blanket orders may show firm and planned commitments for some time in the future (Figure 15). By being provided with the advanced planning information already developed by INVENTORY MANAGEMENT, the supplier can meet delivery dates with more consistency. This will reduce production rescheduling and lower inventories.

SUPPLIER 97045 ACE FORGING CO.
MIDLANDS TOWN

DELIVER TO ALLIED ENGINES CORP
ANYTOWN

DATE 3-27

ORDER NUMBER / ITEM NO.	DESCRIPTION	LAST DELIVERY DATE	LAST DELIVERY QTY	QUANTITIES FIRM 4-7	FIRM 4-14	FIRM 4-21	FIRM 4-28	FIRM 5-5	FIRM 5-12	PLANNED 6-9	PLANNED 7-7	PLANNED 8-4	PLANNED 9-1
97045/ 616743	FGD. CRANK ARM M-20/3	3-24	150		200			200		800	800		800
97046/ 742644	FGD. CRANK ARM M-22/3	3-24	150		200			300		1,000	800		800
03076/ 859821	FGD. GEAR BLANK	3-10	500	500			500		500		1,500		500
05024/ 859862	FGD. GEAR BLANK	2-29	1,000		500		500	500		2,000	2,000	2,000	

Figure 15. Planning information can help suppliers improve their delivery performance

In many of today's systems, blanket orders are issued on a periodic basis, usually after material requirements planning regeneration. With the *net change* approach to material requirements planning discussed in *Chapter 5, Inventory Management,* this is no longer necessary. Revisions to blanket orders have to be issued only when a significant change (percentage deviation from previous plan) has occurred or an order is changed from planned to released.

Codes placed in the item record by the buyer tell the system how far in the future planning information is to be generated.

Normal buyer review and alteration procedures also apply to requisitions generated on a blanket order basis.

Purchase Order Generation

The previously obtained quotation data and automatic supplier selection procedures allow most purchase orders to be generated with little, if any, review by the buyer. This releases much of the buyer's time for concentration on critical, high-cost items.

Upon approval of the system's recommendation and/or the entering of alterations, the purchase order documentation and control record is automatically developed by the system. This can include:

- A printed purchase order.
- An acknowledgment document for use by the supplier. This could be a punched and printed card, which, when returned by the supplier, speeds and simplifies entering the acknowledgment of the order into the system.
- Notification of special requirements from other departments needed to support the order. This could include such things as drawings, tools, and consigned parts.
- Requisition and consignment documents to authorize shipment and to accompany tools and consigned parts.

Additional data is added to the requisition record, which now becomes an open order control record (Figure 16). Details of drawings and tools required are obtained from the item and quotation records and are printed on the purchase order.

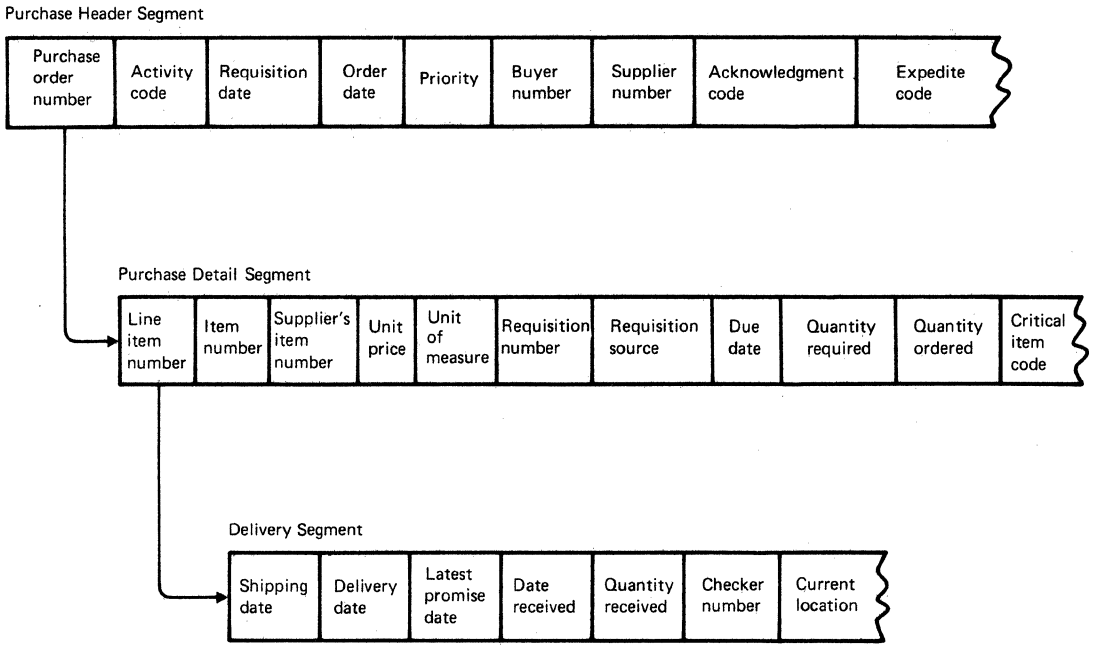


Figure 16. Purchase order record

Supplier releases

Supplier releases are similar to purchase orders and are generally used in conjunction with blanket purchase orders. The price of the parts is negotiated, usually on a year's anticipated requirements, and a blanket purchase order is issued to a supplier for a given quantity at an agreed-upon price. Delivery requirements, however, are not usually provided on the blanket order. These are provided by supplier releases.

Normally, the production schedule is converted into net requirements by time period and a supplier release is prepared. Because the price and the supplier are known in advance, a requisition need not be prepared. In some instances, because prior decisions may stipulate that one supplier is to supply a certain percentage of a given part and another supplier is to supply a different percentage, multiple supplier releases may be prepared. A supplier release will usually specify the quantity to be shipped this time period, the supplier location(s) that is to ship the parts, and planned quantities for future time periods. It also specifies the cost responsibilities and commitments to the supplier.

Because most production schedules are in a constant state of flux, planned schedules change frequently. Also, because most firms have limited storage space and "inventories cost money", the supplier usually holds the inventory and must furnish on short notice (provided by a supplier release) the specified quantity at the time stated. It is necessary, therefore, for both the company that sends the supplier

release and the supplier that receives it to keep an up-to-date file for each blanket purchase order and its associated supplier releases. Quantities shipped and scheduled quantities on order must be constantly posted to this file. Also, orders for the year may be increased, decreased, or canceled, and this can cause price adjustments.

Purchase Order Follow-Up

After the purchase order has been placed, follow-up may be necessary in the form of ensuring that the order has been acknowledged and will be delivered when required. In addition, changes to the order may be processed at any time up to the due date for receipt of the items.

Acknowledgment entry and control

Supplier acknowledgment of order receipt can be designated for all or a limited number of items. The need for acknowledgment is shown in the item record by an order acknowledgment indicator. When the order is placed, a corresponding indicator is entered in the purchase order record. Such indicators may require acknowledgment in all cases, or only if acceptance is made on a different basis from that contained in the order.

The purchase order data is searched periodically by the system for unreturned acknowledgments. This is done on the basis of the amount of time since the order date. All overdue acknowledgment situations are placed in the Buyer's Action File. The buyer can key in a request for a reminder to be printed and sent to the supplier. When he does this, the date is added to the order data, and unless an acknowledgment is received within a fixed number of days, the search for overdue acknowledgments will again put the order in the Buyer's Action File.

The buyer may decide not to process a reminder. For example, he may know that the order is in the process of being acknowledged. The item then remains in his work file until an acknowledgment is entered.

When the acknowledgment is received, it is entered into the system and compared with the details of the order. If they match, the order record is updated to show that an acknowledgment has been received; if not, the order is placed in the Buyer's Action File. When he reviews the item, he may have to negotiate with the supplier to resolve the differences. The unmatched acknowledgment remains in his Action File until a correct one is received or until the buyer modifies the purchase order record.

Purchase order confirmation

Confirming purchase orders is accomplished in a manner similar to that of acknowledgment control. Confirmed items are denoted by an indicator in the purchase order record. This indicator is accompanied by an expediting lead time number representing the number of days before the due date that confirmation should be initiated.

In a periodic review of the order file the system picks out orders requiring confirmation the appropriate length of time before the delivery date. The item is then placed in the Buyer's Action File, and the buyer can initiate an automatically produced confirmation notice for the supplier.

Confirmations of delivery dates are entered in the same way as acknowledgments of orders. The outstanding confirmations are also monitored as before, and placed in the Buyer's Action File when no response to a confirmation notice is received.

When deliveries become overdue the procedure is the same, except that the automatically prepared request to the supplier is usually replaced by direct contact by the buyer.

Changes to orders

Changes to purchase orders are created by INVENTORY MANAGEMENT as the result of changes in the production schedule, excessive scrap in production, etc. They may appear as quantity or date changes to open purchase orders, or as new orders overlapping existing ones.

When the buyer reviews the item he can request a display of existing orders. The result of this review may be a decision to place an additional order or to change an existing one. Depending on the lead time remaining, this may require either negotiation or the immediate production of an order amendment notice to the supplier. The order amendment is printed as soon as any necessary negotiation has been completed. It is similar in form to the original order and contains the original order number.

Details of the order change (date, type of change, new quantity or date, etc.) are added to the order record. All changes are retained in the order record so that a complete history of the order is available.

Purchasing Planning and Evaluation

The purchasing data accumulated and maintained for quotation and order control can be used to provide a basis for planning and evaluation of purchasing functions. Areas for which this data can be used include:

- Purchasing department workload planning
- Purchasing commitment planning
- Purchasing performance evaluation

Purchasing department workload planning

Workload planning in the purchasing department is based on buyer load. Plans are developed from a review of the planned orders for purchased items developed by INVENTORY MANAGEMENT, in conjunction with the current rate of order placement by buyers.

In a real-time system in which many orders are generated automatically, a small change in the amount of buyer participation in order generation has a significant effect on the purchasing workload. Factors affecting this workload include:

- The proportion of total orders handled by the system automatically, without review by the buyer (this may vary – particularly during the purchasing load from a new product introduction)
- The proportion of total orders created by the system and reviewed by the buyer without change
- The proportion of total orders created by the system and altered by the buyer
- The proportion of requisitions entered manually in the purchasing department
- The ratio of order changes to orders processed

Purchasing commitment planning

Cash required for payment of suppliers' invoices can be forecast accurately as soon as the commitment to the supplier is made – that is, when the purchase order is generated. When the purchase order record is created it is made available to the financial executive's planning system. This system can calculate the order value, and can estimate the supplier payment date on the basis of the order delivery date, the normal delay before receipt of invoice, and the payment cycle in Accounts Payable. If the supplier offers a cash discount for fast payment, this is taken into account when the payment date is estimated.

The forecast of cash payments is updated as each purchase order record is created. If estimated payments for a specific period are out of line with financial plans, cost planning personnel can review the order

records responsible. The review of cash payment forecasts can take place before the orders causing out-of-line situations are released to suppliers.

Purchasing performance evaluation

To measure the buyer's success in selecting suppliers for optimum delivery and quality performance, it is necessary to look at the performance of the suppliers he selects. When buyers are organized by commodity type, the current performance of suppliers can be summarized by type to provide an index of performance for the individuals responsible for them.

Delivery and quality performance of suppliers, however, cannot provide an adequate measure of the purchasing function, unless price performance is also taken into account. To do this the total cost of purchases is compared with the standard cost of the purchased items for the current period. This comparison therefore provides a measurement of the extent to which profit objectives are being met by Purchasing.

One type of performance report for purchasing management appears in Figure 17.

PURCHASING DEPARTMENT PERFORMANCE PERIOD 08

		----PRICE----		---QUALITY--		--DELIVERY--	
		PERIOD	YTD	PERIOD	YTD	PERIOD	YTD
BUYER	20	93.3	100.8	81.1	79.9	6.8	6.8
	21	98.4	99.3	72.4	80.1	9.2	10.1
	23	93.7	94.2	82.3	86.7	4.7	6.0
	25	97.2	102.2	84.5	86.2	11.4	8.6
	26	99.1	98.4	80.8	90.8	4.8	5.3
	28	96.1	95.5	73.6	80.5	9.8	10.3
	29	95.1	96.4	77.7	79.3	8.5	8.3
GROUP	A	96.4	98.6	78.7	82.5	7.8	8.0
BUYER	32	101.5	101.9	69.1	80.8	7.5	7.4
	33	99.5	101.3	85.0	87.3	-	-
	34	98.4	98.1	95.5	95.6	3.6	4.5
	35	100.8	99.9	94.3	92.6	5.8	5.4
	36	99.1	97.0	90.8	89.5	5.3	4.9
GROUP	B	99.6	99.9	92.3	91.5	5.6	5.5
DEPT.		97.7	99.2	85.4	86.8	6.8	6.9

Figure 17. Purchasing department performance report

In most companies 80% to 90% of the shipments coming from suppliers cause no problem. Order numbers and quantities tally with the original documents, inspection is straightforward, and the materials arrive in stores well in time to meet production requirements. It is the other 10% to 20% that cause problems – such as:

- Arrival of material with no paperwork or insufficient identification, so that time must be spent searching through files and phoning the buyer or supplier to find out what has arrived.
- Loss or delay of critical items at the receiving dock because nobody knew they were urgent.
- Determining who should be advised of the receipt, in the case of parts designated as critical.
- Determining whether a shipment needs inspection and, if so, to what standards, and whether the inspection should be complete or partial.
- Finding out where to send the item once it is checked and inspected. On critical items, for example, should a partial quantity be sent direct to the shop floor or should the whole shipment go to stores first?
- Deciding whether an overshipment should be accepted or whether the excess pieces should be returned to the supplier.
- Deciding whether off-standard material should be sent back to the supplier or be accepted because of a production shortage.

Finding answers to these and similar problems takes a major portion of the time and effort of Receiving, Inspection, and Purchasing personnel.

The RECEIVING system is aimed at minimizing these problems. It also reduces from days to hours, or even minutes, the amount of time between receipt and storage. The result is better use of the existing receiving space, reduced handling, and elimination of most recordkeeping by nonclerical receiving personnel.

Functions

The functions of RECEIVING, as illustrated in Figure 18, are to:

- Identify incoming materials and verify that they were ordered.
- Check the quantity received against the delivery documents and see if it is reasonable in relation to the quantity ordered. Purchasing is immediately notified of receipts above or below a specified level so that, for example, disposition can be made of excess items while the supplier's vehicle may still be in the receiving area.

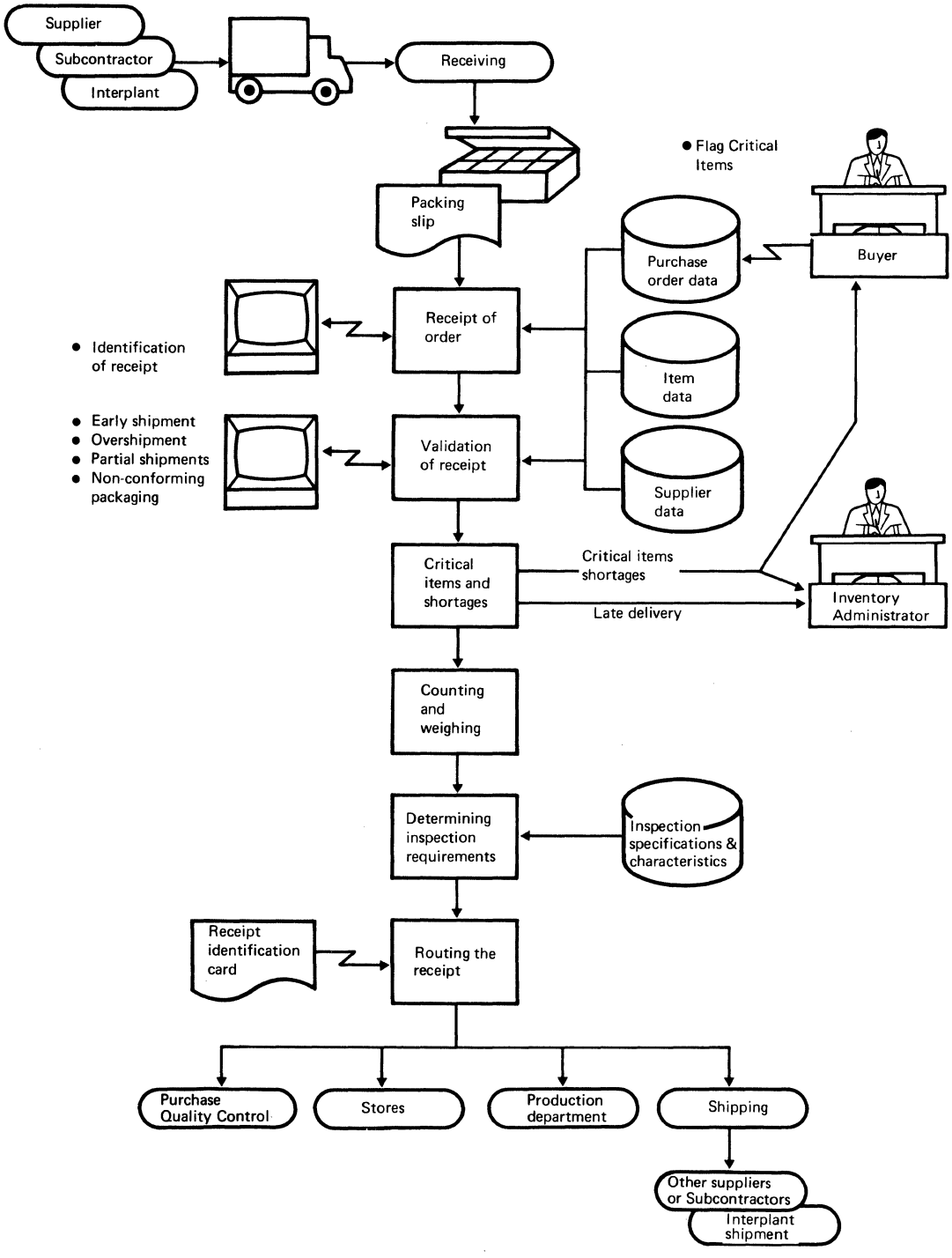


Figure 18. Functions of Receiving

- Determine whether the items must be inspected or whether inspection can be bypassed. This avoids the inspecting of more samples than necessary or the failure to inspect goods that should be inspected.
- Produce receiving identification documents to accompany the items from receipt to final destination.
- Count or weigh the incoming items and reflect the actual receipt in the order record, so that the supplier is paid for the material actually received and the inventory records are updated correctly.
- Notify the buyer and inventory administrator of the receipt of critical items in order to reduce expediting effort. The relative priority of receipts can be determined to ensure that they are processed in the correct sequence.
- Fill shortages in a priority sequence as soon as possible after receipt.
- Maintain the location and status of all receipts so that items do not get lost or mislaid and inquiries as to order status can be made at all times.
- Determine where the items should be moved to – Stores, Inspection, using department, Reclamation, or back to the supplier.
- Determine the future workload on Receiving, on the basis of planned receipts, in order to anticipate overloads and slack time.
- Coordinate related activities with other areas – Inspection and Quality Control, Purchasing, Stores, Production Control, and Accounts Payable.

Types of receipts

All types of receipts are handled by one system. It is not necessary for Receiving to employ different procedures for different types of material. The types of receipts considered are:

- *Purchased materials and components.* Item number and purchase order number must be identified from information provided by the supplier. The procedures described provide a rapid method of identifying these items.
- *Interplant items.* These include components or subassemblies supplied by another division or plant for incorporation into finished products.
- *Subcontract items and assemblies.* Certain components and assemblies may be made at outside contractors because of lack of capacity or facilities in the plant.
- *Consigned material or items.* These are parts supplied by a customer for incorporation into his order.

- *Custom-bonded items.* Items imported from another country for use in a product to be exported are identified and held in bond by Customs until assembly in the finished product.
- *Returned items.* These include surplus components from consignments to suppliers, rejected items from suppliers, other plants or customers, excess inventory from other plants, etc.
- *Manufactured items.* In a number of companies, components and assemblies made in the plant go through the same Receiving and Quality Control procedures before delivery to stores.
- *Non-production items.* Maintenance supplies, desks, stationery, etc., can also be incorporated into the system.
- *Containers.* Returnable containers, pallets, etc., from customers are normally returned to the receiving area. STORES CONTROL maintains a record of consigned and available containers.

Identifying Receipts

Material arriving at the receiving area is normally accompanied by a packing slip, advice note, interplant move note, or similar document containing the original purchase order number, item number, and quantity.

The receiving clerk enters the purchase order number and "receipt acknowledgment" code into the terminal located in the receiving area. This causes details of the purchase order to be displayed (Figure 19). The clerk verifies the details in the packing slip against the displayed record, and enters the quantity received in this shipment against each of the line items, along with the present location of the material.

As Figure 20 shows, the transaction updates the status of the purchase order record to "in receiving department", and the system checks the following:

- Validity of receipt for such things as quantity discrepancies, early delivery, and so on
- Whether the items received are designated as "critical" or resolve shortages
- Whether the receipt has to be counted or weighed
- What the inspection requirements are for the item
- Where the items are to be routed – say, direct to stores, to a production department, or to another plant

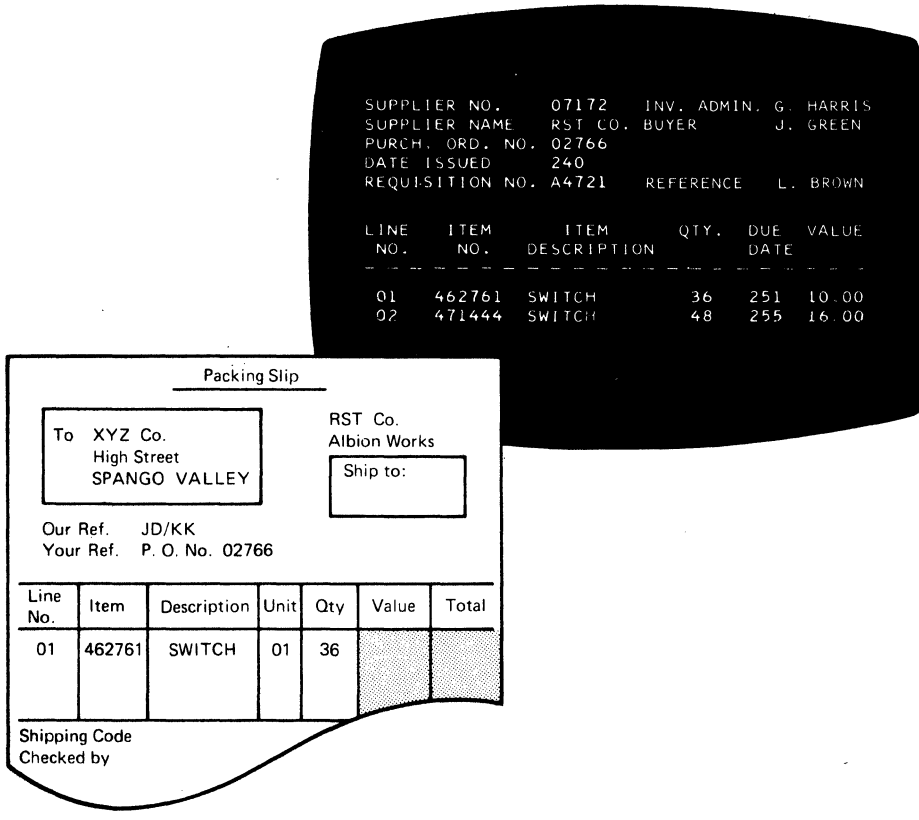


Figure 19. Purchase order details are displayed and verified against the packing slip

Upon identification of the receipt, the system transmits back to the terminal a punched receipt identification card containing further handling instructions – counting, inspection, stores destination, etc. If multiple containers are required, the receiving clerk can request via terminal that additional identification cards be immediately transmitted.

With this procedure, copies of purchase orders and files of punched identification cards need not be maintained in the receiving area to identify incoming materials and items. This eliminates the problem of maintaining these files, which means that:

- Documents are not lost or misfiled.
- Changes between the time of placing the order and the time of receipt do not need to be handled by receiving personnel.
- Additional documents need not be created to handle partial shipments. This, in turn, means that delays in waiting for the new documents, along with temporary file inaccuracies, are eliminated.

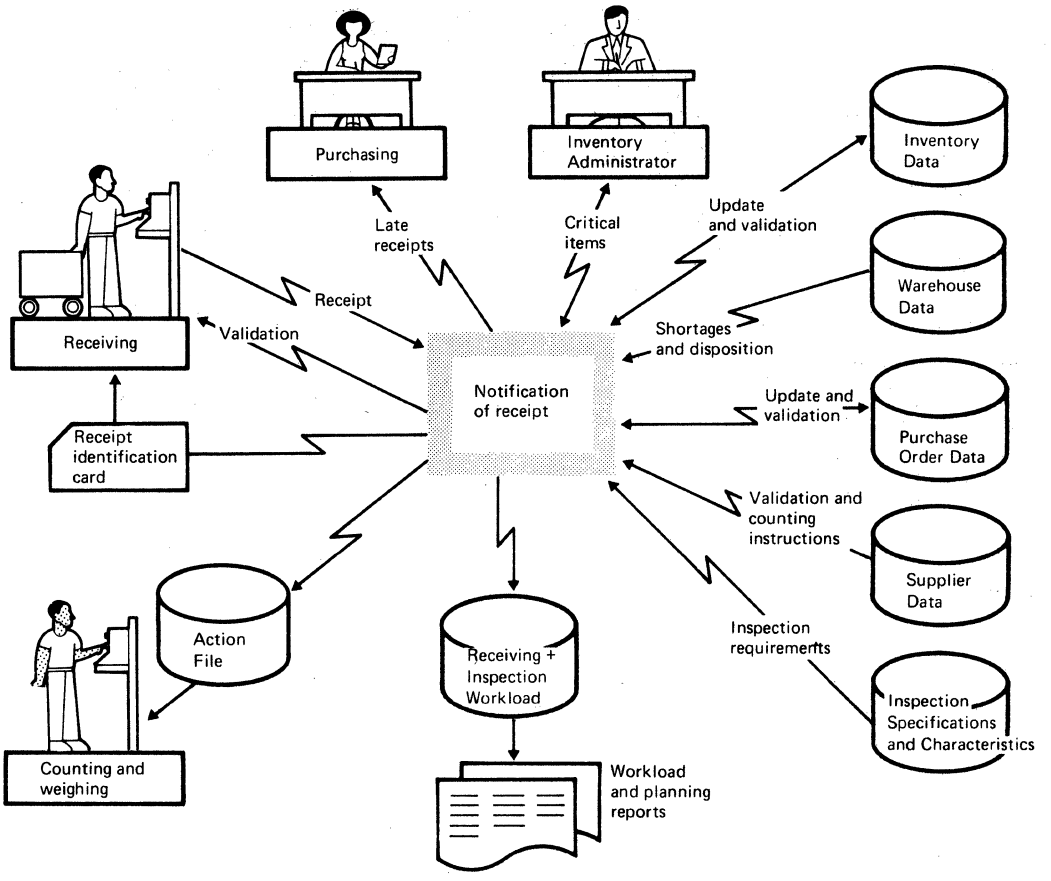


Figure 20. Notifying the system of receipt of an order triggers a number of events

Receipts at other locations

Certain receipts will be at locations other than the normal receiving area. For example, building materials, heating supplies, chemicals, food, and large, bulky items are usually sent direct to the using department.

Documentation covering the receipt, such as an advice note, can be sent to Receiving to enter and validate the receipt just as for other items. The secondary receiving area may have its own terminal, if its volume of receipts so warrants.

Identifying undocumented receipts

While most items arriving at the receiving dock are identified by the purchase order number and item number, some items arrive from suppliers with incorrect or missing paperwork. Other items arrive with paperwork which is correct but for which no corresponding record can be found. The system can assist in the necessary identification.

missing or incomplete paperwork

It may be necessary to identify a receipt by one of the following pieces of information: supplier number (or plant, in the case of interplant shipments), item number, item name, quantity, line item reference number, supplier's own part number, or supplier's document reference number.

Receiving alone may not always be able to handle such cases. For instance, if only the supplier's name were known, the receiving clerk would enter into the terminal a code requesting identification of receipt, along with the supplier's name, a physical description of the item, and the approximate quantity (Figure 21). This information would be put into the Action File of the buyer normally handling that supplier and would be displayed on his visual display screen. The system would also display a summary of all orders due from that supplier within the next few weeks (Figure 22). The buyer could request a display of details of the most likely orders. From this information and the physical description of the parts, he could determine which order had been received.

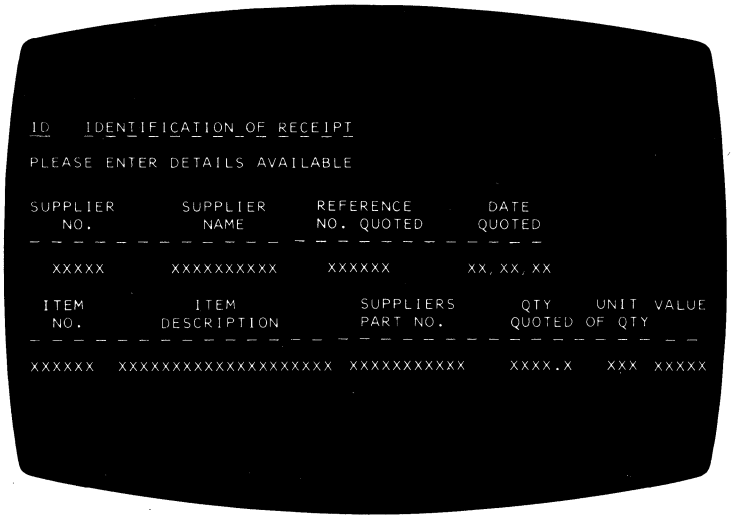
In other cases the receiving clerk can immediately identify the order himself by inquiring into the system. For instance, a cross-reference list showing the item number and equivalent supplier part number is held by the system in the Purchase Quotation File (see "Purchasing"). If only the supplier's part number is known, this can be entered into the terminal, causing the equivalent item number to be displayed plus all the outstanding purchase orders for this item. Details of the orders most likely to correspond to the receipt can be displayed to help determine the correct one.

purchase order record not found

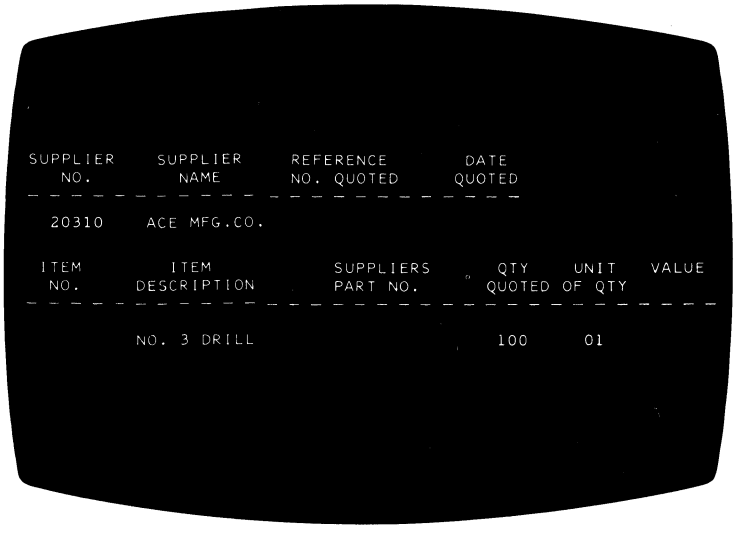
Even though the packing slip is present, the equivalent purchase order record may not be immediately locatable – possibly because:

- Wrong details are quoted on the packing slip.
- No order was ever placed for these items – the supplier shipped to the wrong customer.
- This is a duplicate shipment – the order has already been received.
- A telephone order was placed for which no paperwork was created.
- Delivery was made to the wrong location.

The visual display terminal located in Receiving is again used for identification. Keying in the supplier number can cause details of all current and recent orders to be displayed. If a centralized computer system is used, orders for delivery at other plants can also be shown. From this information it may be possible to determine the correct order number and whether it is a duplicate shipment or has been delivered to the wrong address. Where the order still cannot be identified, the query can be referred to the buyer to resolve with the supplier.

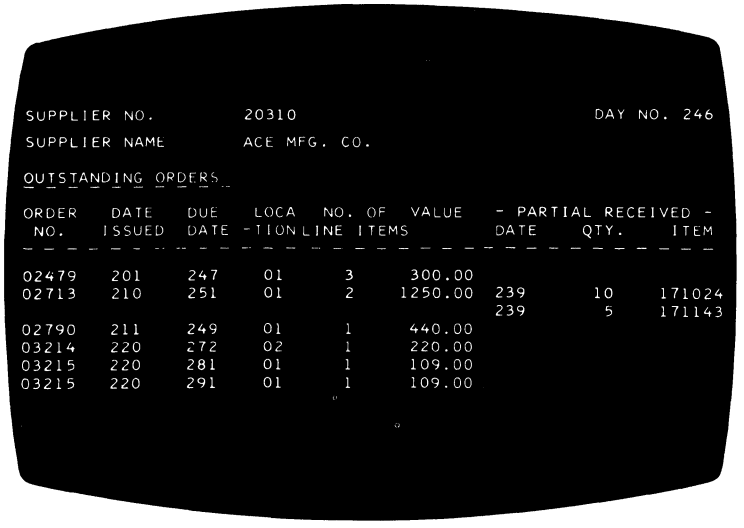


The receiving clerk enters a code (ID) requesting identification of the receipt. The system responds by requesting entry of as much detail as is available.



The receiving clerk enters the details, which are supplier number, description of the item received, and quantity.

Figure 21. Where only limited information is received, the order can be identified by displaying outstanding orders on the particular supplier (Sheet 1 of 2)



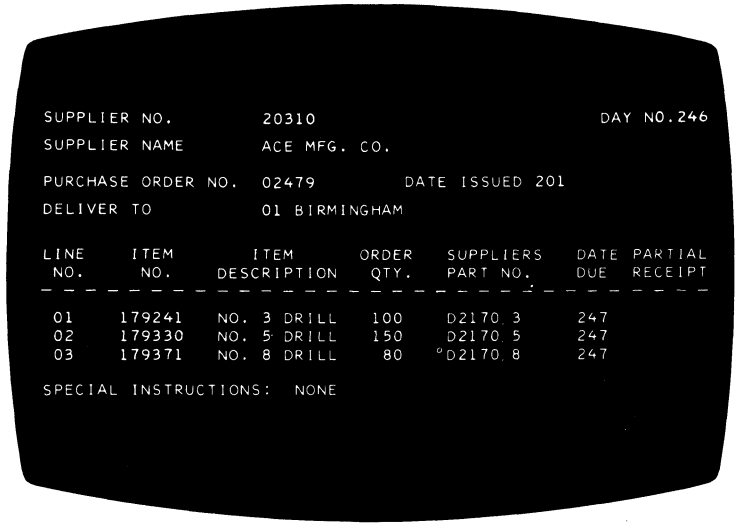
SUPPLIER NO. 20310 DAY NO. 246

SUPPLIER NAME ACE MFG. CO.

OUTSTANDING ORDERS

ORDER NO.	DATE ISSUED	DUE DATE	LOCATION	NO. OF LINE ITEMS	VALUE	- PARTIAL RECEIVED - DATE	QTY.	ITEM
02479	201	247	01	3	300.00			
02713	210	251	01	2	1250.00	239	10	171024
						239	5	171143
02790	211	249	01	1	440.00			
03214	220	272	02	1	220.00			
03215	220	281	01	1	109.00			
03215	220	291	01	1	109.00			

The information is displayed on the buyer's screen together with a summary of all orders due from that supplier in the next few weeks.



SUPPLIER NO. 20310 DAY NO.246

SUPPLIER NAME ACE MFG. CO.

PURCHASE ORDER NO. 02479 DATE ISSUED 201

DELIVER TO 01 BIRMINGHAM

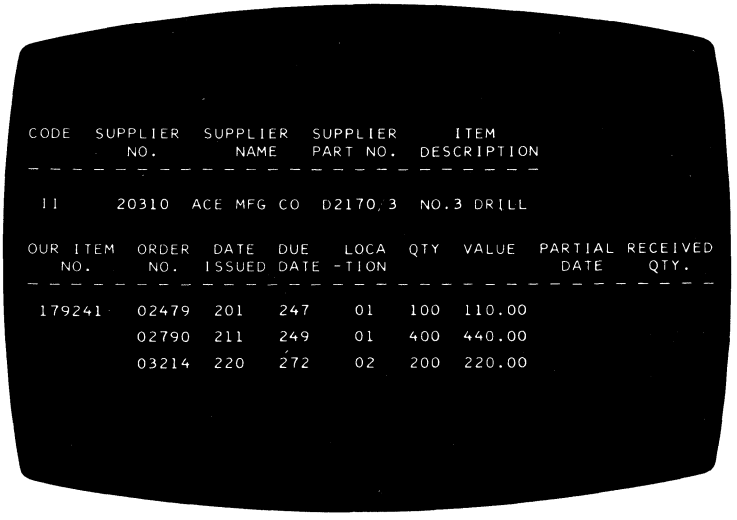
LINE NO.	ITEM NO.	ITEM DESCRIPTION	ORDER QTY.	SUPPLIERS PART NO.	DATE DUE	PARTIAL RECEIPT
01	179241	NO. 3 DRILL	100	D2170 3	247	
02	179330	NO. 5 DRILL	150	D2170 5	247	
03	179371	NO. 8 DRILL	80	D2170 8	247	

SPECIAL INSTRUCTIONS: NONE

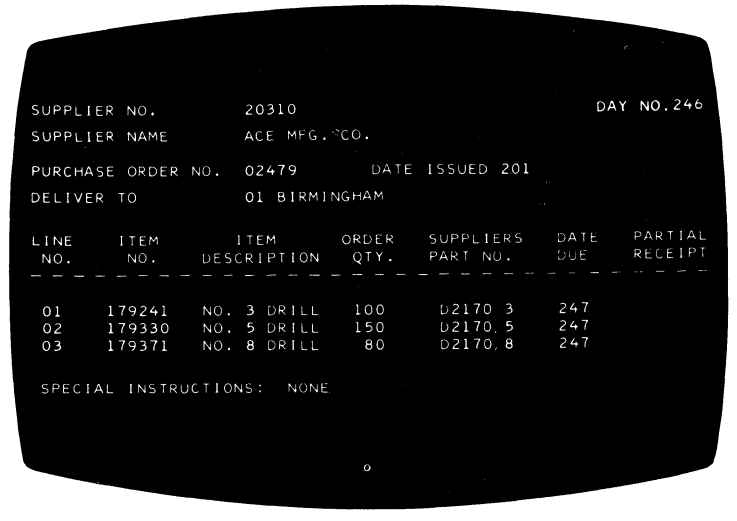
The buyer can select the orders most likely to correspond with the receipt and request details to be displayed. He may need to contact the supplier for more confirmation.

Figure 21. Where only limited information is received, the order can be identified by displaying outstanding orders on the particular supplier (Sheet 2 of 2)

The receiving clerk enters the supplier's number and the supplier's part number into the terminal together with a code requesting Item Identification (II). The corresponding item number and description are displayed together with a list of outstanding purchase orders for the item.



The system responds by displaying the equivalent item number used within the company together with a list of outstanding purchase orders for the item.

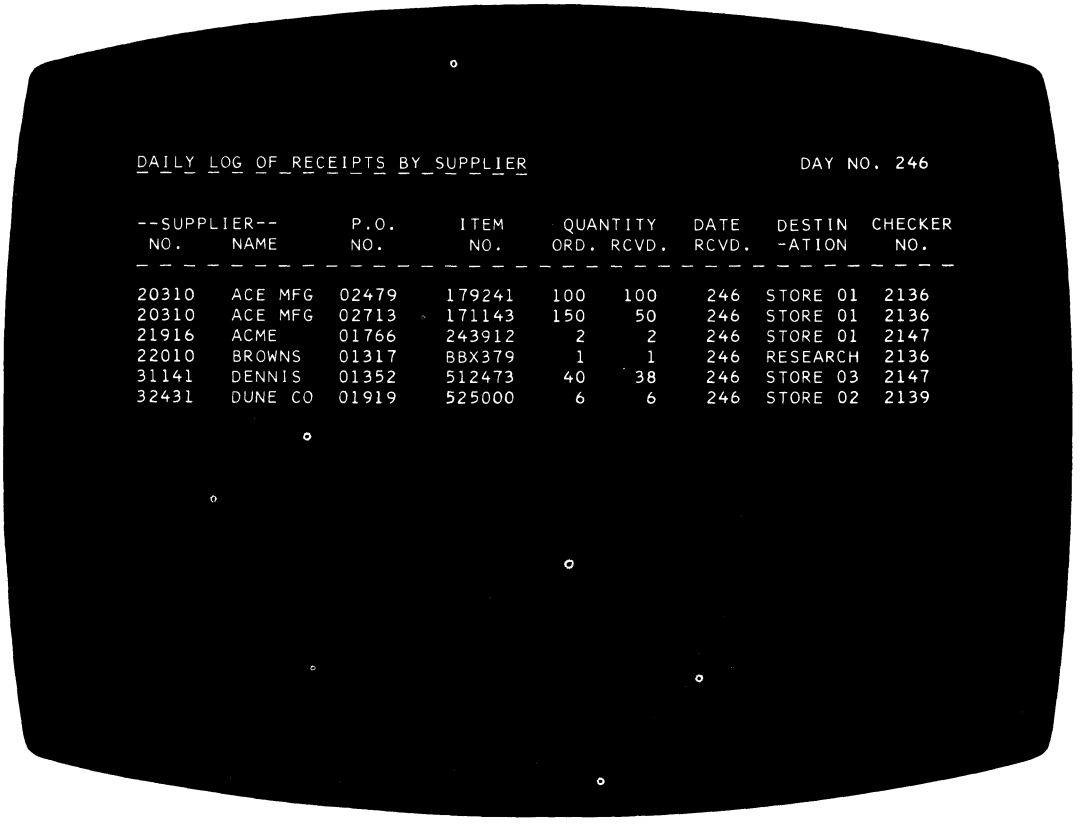


The receiving clerk can request the purchase order details to be displayed in order to identify the receipt. He may have to refer to purchasing for confirmation.

Figure 22. The correct purchase order record can be obtained by entering the supplier's own part number into the system

Log of receipts

Receiving need not log all receipts as they arrive; the system keeps a log of all receipt transactions for audit purposes. The data can be displayed immediately upon inquiry, as shown in Figure 23. It can be in sequence by time of receipt, supplier number, item number, inventory administrator, buyer number, or any other desired way.



DAILY LOG OF RECEIPTS BY SUPPLIER — DAY NO. 246

--SUPPLIER-- NO.	NAME	P.O. NO.	ITEM NO.	QUANTITY ORD.	QUANTITY RCVD.	DATE RCVD.	DESTIN -ATION	CHECKER NO.
20310	ACE MFG	02479	179241	100	100	246	STORE 01	2136
20310	ACE MFG	02713	171143	150	50	246	STORE 01	2136
21916	ACME	01766	243912	2	2	246	STORE 01	2147
22010	BROWNS	01317	BBX379	1	1	246	RESEARCH	2136
31141	DENNIS	01352	512473	40	38	246	STORE 03	2147
32431	DUNE CO	01919	525000	6	6	246	STORE 02	2139

Figure 23. A daily log of receipts is maintained automatically by the system and can be retrieved upon request

Validation of receipt

As soon as the receipt is identified at the terminal, an edit check is made to see if it is valid. The system can recommend the action to be taken, or notify the buyer or inventory administrator that action is required. Checks are made for:

- Early receipt
- Overshipment
- Partial shipments
- Pack sizes, pallets, or packaging not conforming to warehouse standards

early receipt

The receipt of items before they are due results in excess inventory and the need for extra warehouse space. Suppliers sometimes ship early to reduce their own inventory costs. Often the buyer is unaware of the problem because he is concentrating on late orders and is only too pleased if orders arrive ahead of time.

The system automatically checks for receipts that are early by more than a specified amount of time. Receiving is immediately notified not to accept the items but to return them to the supplier. This can often be done while the delivery vehicle is still at the receiving dock. A high-priority action notice is sent to the buyer and inventory administrator to confirm rejection of early receipts. The rejection may be overridden after consultation with the supplier.

overshipments

The quantity specified on the packing list is checked against the quantity ordered. The receiving area is immediately notified of overshipment by more than a certain amount. The overshipment tolerance may be stated on the original order and may be based on item or inventory class (say, more than 2% on class A items, 5% on B items, and 10% on C items – see "Inventory Classification" in *Chapter 5, Inventory Management*). The excess may be shipped back immediately or after Inspection has checked for rejects.

partial shipments

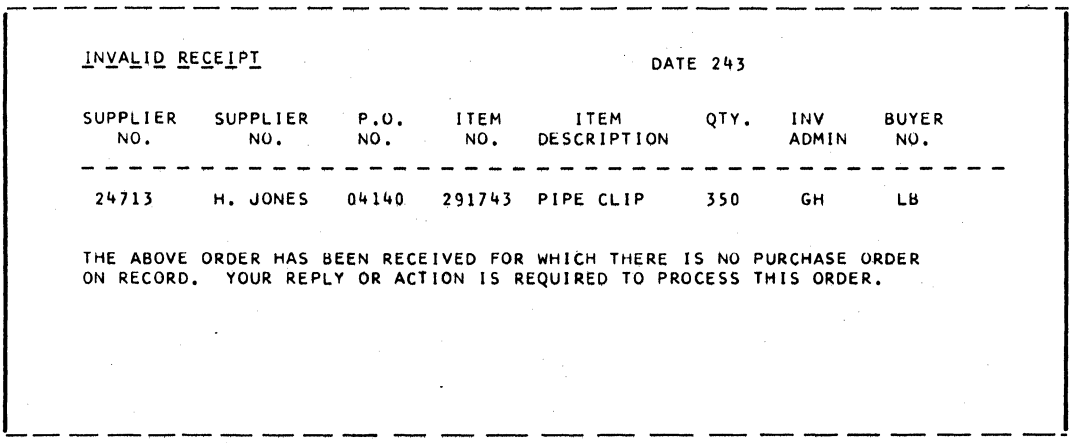
The buyer is immediately notified in the event of any receipt of less than the quantity planned, so that he can check with the supplier.

nonconforming packing

Because of standardized storage facilities, as in the case of an automated warehouse, certain packing restrictions may be made on suppliers – for example, everything should be on standard pallets or conform to certain pack sizes to suit the storage facilities. The receiving clerk enters a special code at the terminal for orders deviating from these standards. The order record is checked to see whether the item is on shortage or is "critical" before being sent back to the supplier. If the rejection is likely to cause a future shortage, the decision is referred to the inventory administrator and buyer via Action File notices.

notification of invalid receipts

In the case of invalid receipts, the appropriate buyer and inventory administrator are notified. A message is put on their Action Files detailing the suggested action, such as returning all overshipments, or requesting a decision (Figure 24).



INVALID RECEIPT DATE 243

SUPPLIER NO.	SUPPLIER NO.	P.O. NO.	ITEM NO.	ITEM DESCRIPTION	QTY.	INV ADMIN	BUYER NO.
24713	H. JONES	04140	291743	PIPE CLIP	350	GH	LB

THE ABOVE ORDER HAS BEEN RECEIVED FOR WHICH THERE IS NO PURCHASE ORDER ON RECORD. YOUR REPLY OR ACTION IS REQUIRED TO PROCESS THIS ORDER.

Figure 24. Notification of an invalid receipt, such as an overshipment, is made to the buyer and inventory administrator for action. It may be either printed hard copy or a display

Expediting Critical Items

One thing checked at time of receipt is whether there are any outstanding shortages (back orders) for the item, or whether the item is designated as *critical.* An example of a critical item might be a machine casting which because of its size is not held in Receiving or Inspection but is sent straight through to the assembly area.

Although not necessarily behind schedule, critical items are of such importance to production that notification of receipt is immediately sent via Action File to the inventory administrator, Purchasing, and the assembly shop foreman.

shortages

The inventory administrator has the ability to designate any outstanding shortage as critical by entering a brief message into his terminal, for example, order number and "critical" code. This means that he is to be notified immediately if any order (or a particular order) for this item arrives. The system so advises him and lists all outstanding shortages for the item (Figure 25). He replies through his terminal, stating the sequence in which he wants the shortages filled.

If the order is not tagged as critical, the system determines the sequence in which the shortage should be filled, according to the allocations made in INVENTORY MANAGEMENT. Most shortages are filled in this way.

The buyer is immediately notified of the receipt of late orders, to prevent unnecessary expediting effort.

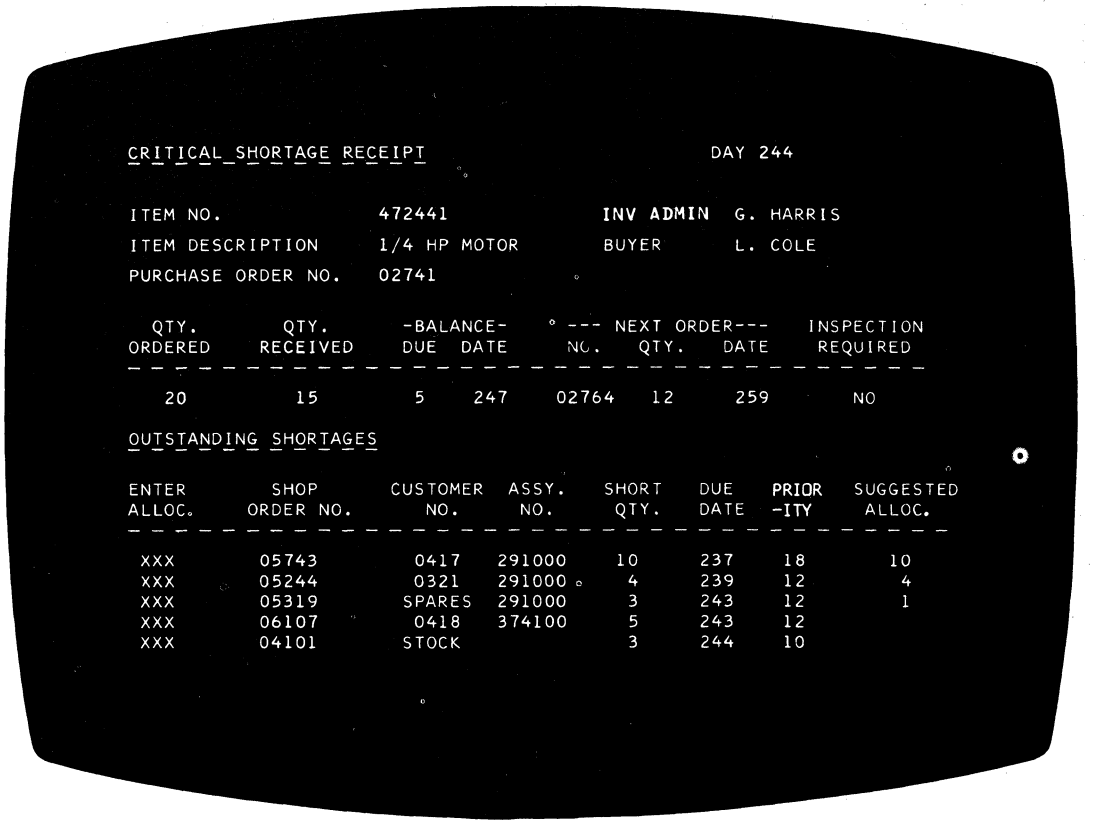


Figure 25. The inventory administrator can be immediately notified of the receipt of items needed to meet critical shortages

Determining Receipts to Count

The system notifies Receiving which shipments should be counted or weighed, either by a figure carried in the supplier record (indicating, say, every fifth shipment from the supplier) or on a random basis that can be determined by the system. The number of shipments or samples of shipments to be checked is based on experience with the particular supplier. Shipments from suppliers with a previous record of undershipment are checked more frequently.

counting sequence

To satisfy legal requirements, counting may be necessary at the point of receipt. In most cases, however, it is done either before or during inspection. Items that have to be counted or weighed are held in priority sequence in a Counting Action File. The priority sequence is based primarily on due date but can also be based on factors such as priority of the order for which the items are intended, whether the item is critical or short, whether a high reject rate is expected, number of pieces to be counted or weighed, whether inspection is required or not, etc.

The checker reports completion of a job by inserting the receipt identification card, his man number or badge, and the quantity counted into a work area terminal (see *Chapter 8, Plant Monitoring and Control* for a description of these terminals). To ensure that a count is actually made, the identification should not contain the ordered quantity.

reporting
piece count

If the count is outside predetermined limits, the system can ask for a recount. The limits can either be set as a percentage or be based on empirical rules.

Weighing machines can be attached via terminal to the plant communication system. The results are posted direct to the records and do not have to be entered into the terminal by the receiving clerk (Figure 26). The material being weighed is again identified by the receipt identification card.

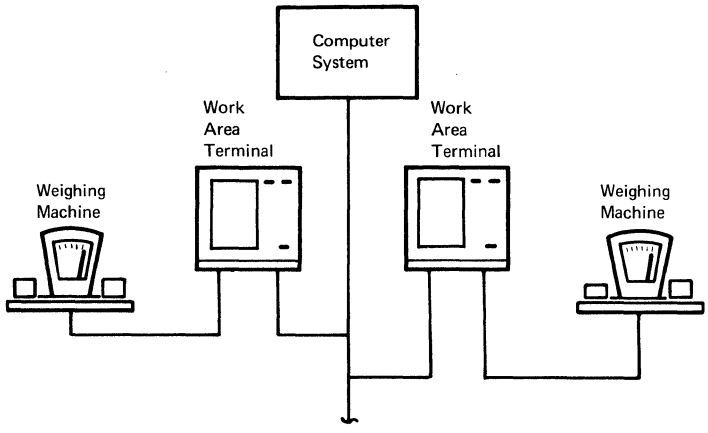


Figure 26. Weighing machines can be linked direct to the computer via a terminal located in the receiving area

When a count is reported at the terminal, the next job in sequence in the Counting Action File is dispatched to the checker. The counting details are printed on the terminal together with any repacking, handling, or other special instructions (Figure 27). The checker is assumed to start on the next job upon completing his current job.

count
dispatching

Dispatching work to the checker in this way ensures that he works first on the highest-priority receipts, because newly received critical deliveries automatically head the queue.

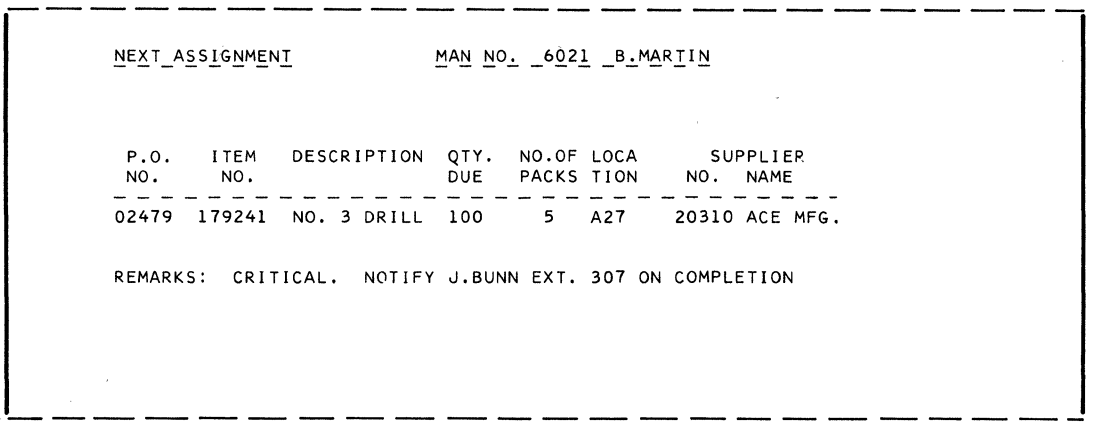


Figure 27. The next job is dispatched to the checker when he completes his present job

Inspection Requirements

The system checks every receipt to determine what inspection requirements are necessary. It is possible that a receipt may be:

- Completely inspected – if all parts must be checked to quality standards
- Partially inspected – if only a sample of the shipment needs to be checked
- Not inspected at all – if items from a certified supplier can bypass inspection and go direct to stores

The system checks the supplier record to see whether the supplier is *certified*, that is, whether shipments can be accepted with either a partial or no inspection. The purchase order record also indicates whether this particular shipment should be inspected (for example, it may be that only every fifth shipment from this supplier is to be checked).

engineering changes

A further check is made to see whether any engineering changes have taken place since the last receipt from this supplier. If so, the items can be routed through inspection regardless of any other consideration to make sure the change has been incorporated.

Routing the Receipt

Once it has been determined whether the receipt is valid, whether the items are critical or short, whether the pieces have to be counted, and what inspection requirements have to be met, the routing instructions are transmitted to the receiving area terminal. The routing instructions

are usually typed at time of receipt identification. However, if there is trouble identifying or validating the receipt, they would be transmitted later. As Figure 28 illustrates, routing instructions may specify that the parts are to be held for counting or that they should be sent to:

- Inspection
- Specific storeroom(s) or warehouse(s)
- A user department
- Another supplier or plant
- The supplier

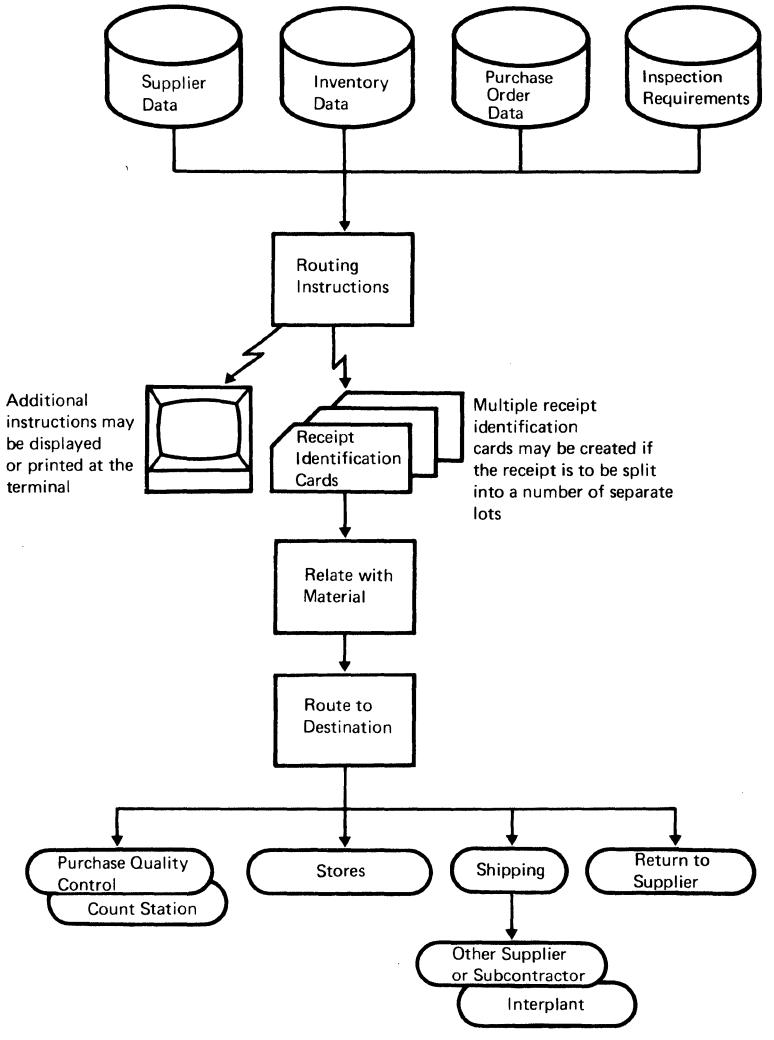


Figure 28. Routing instructions specify the destination of each receipt

Routing instructions are transmitted in the form of a *receipt identification card* (Figure 29) punched out at the receiving area terminal. There may be more than one such card if multiple containers are used. Additional printed routing or handling instructions may also be transmitted if necessary.

The receipt identification card is used to identify the order and to report movement and status while the items are traveling from Receiving, through Inspection, to their final destination. The instructions on the card tell Receiving personnel where to send the items:

- *Inspection.* Items requiring inspection or counting are routed to the inspection area. The receipt identification card is inserted into a terminal and the system prints out the quantity to be inspected and any special instructions (see "Purchase Quality Control").
- *Counting.* Counting or weighing may be done before or after inspection. The need for counting and weighing will also be indicated, and special counting instructions can be printed on the terminal.
- *Stores.* If dispatching direct to stores is indicated, the receipt is moved straight to the specified location. If the lot has to be divided among several storerooms, the system automatically produces one receipt identification card for each location.
- *Using department.* In the case of critical items, shortages, or items ordered specifically for a particular user, the complete or partial lot may be sent direct to the using department. Special information, such as shop order number, man number of the person requisitioning the item, etc., can be printed on the card.
- *Another supplier or plant.* Items to be forwarded direct to another supplier or plant are normally sent straight to Shipping after inspection and counting. Such items are purchased parts ordered at a central location for all plants, or purchased parts for consignment to subcontractors. A message would be put on the shipping department's Action File to prepare documentation.
- *Supplier.* Because of early shipment or overshipment, all or part of a receipt may have to be returned to the supplier. A receipt identification card is punched for that part of the shipment that has to be returned. A message is generated for shipping to prepare return documentation.

STORES CONTROL prepares shipping documents, and the purchase order record is updated when the items have been dispatched.

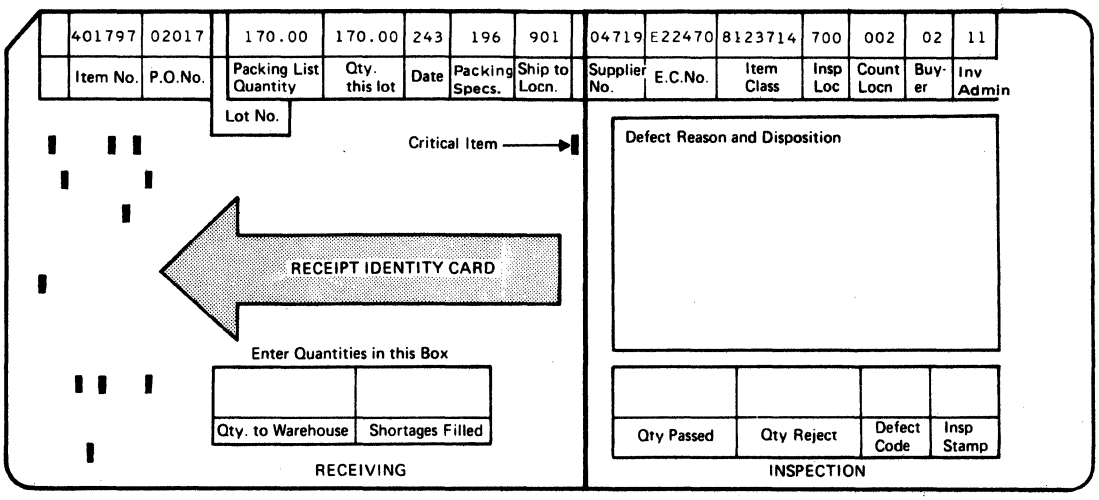


Figure 29. A punched card identifies the receipt and can be used to report all movement and status from time of receipt to final destination

Communication System Benefits

The RECEIVING system utilizes the plant communication system to determine whether incoming receipts are supported by a valid order, to recognize exceptional or error conditions, and to immediately notify areas such as Production Control and Purchasing of these conditions so that they can take action at the time the event occurs. The same system also directs incoming shipments to their proper destination, makes sure that shortages are filled in priority sequence, and records all receiving transactions as they occur. As a result, inventory records accurately reflect what has arrived and is available for production. The incidence of lost material is reduced and parts critical to production are quickly expedited to the required location without extra handling. Less inventory is tied up on the receiving dock and in inspection, and the items are available much sooner.

Purchase Quality Control

PURCHASE QUALITY CONTROL refers only to those quality assurance activities related to purchased items, subcontracted items, and items received from other plants. Its purpose is to ensure that items coming into the plant are of an acceptable quality level.

The responsibilities and functions of Quality Control are not completely covered in this chapter. Some of them have been treated in *Chapter 8, Plant Monitoring and Control* – for example:

- Quality control for manufactured items, and direct control of test equipment (see "Manufacturing Quality Control")
- Tool and gauge control (see "Tool Control")

Other functions, such as determining physical testing standards, reliability control, and inspection procedures, are also not presented. As a general guide, only those functions are discussed that affect the status of the purchase order as it passes through the inspection and testing facilities before being moved to stores.

As with other areas of the system, stress is placed on simplifying the collection of information by means of terminal reporting.

Relationship with Receiving

Receiving and Purchase Quality Control are extremely closely related. At the time delivery is made, Receiving must be able to determine whether inspection is required. If it is, control of the receipt must be given to Quality Control, where the material is inspected, the results recorded, and the receipt forwarded to the proper destination.

Receiving provides the following information for Quality Control:

Item identification

Notice of receipt of an order

Priority of the receipt

Location and status of receipts in process

Engineering change number associated with the material received

Functions

The functions of PURCHASE QUALITY CONTROL, as shown in Figure 30, are:

- Determining inspection requirements – providing information regarding the inspection standards, sampling techniques, and the lead time needed for inspection
- Inspection reporting – inspecting, testing, and reporting on the quality of production items received, and transmitting the results to PURCHASING, STORES CONTROL, and INVENTORY MANAGEMENT

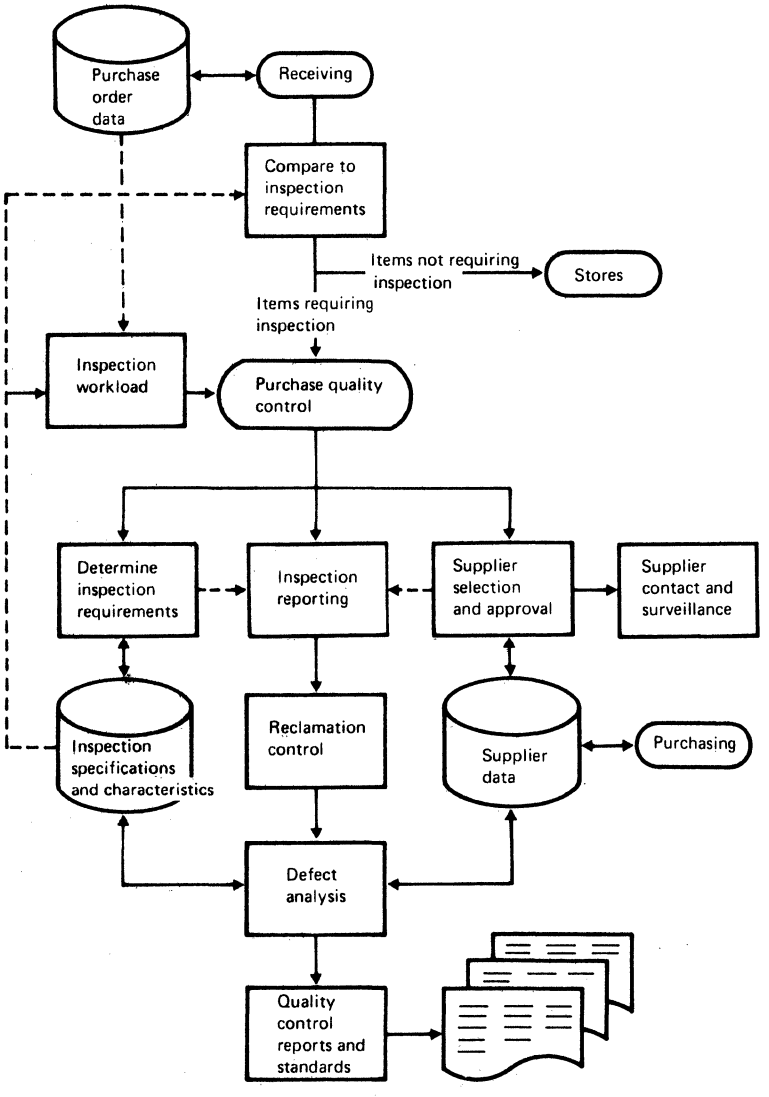


Figure 30. Functions of PURCHASE QUALITY CONTROL

- Reclamation control – providing status information on nonconforming items to Manufacturing and Purchasing, and determining the disposition of these items (accept or return to supplier, rework or scrap, etc.)
- Defect analysis and supplier quality rating – analyzing defect information, by supplier, item, and cause (this information will be used to provide supplier analysis ratings and purchased part history, and to determine future rejection allowances)
- Inspection workload – providing future workload estimates in the inspection department based on planned receipts, in order to anticipate overloads and slack time

Determining Inspection Requirements

Quality Control is responsible for determining inspection requirements for all items. For a particular item, these requirements may vary by supplier.

New sources of supply

Quality control data regarding newly approved suppliers is entered into the system by Inspection.

PURCHASING updates the supplier record to indicate the new items or types of items approved for supply, and it updates the item record to indicate the additional supply source. Quality Control must then indicate whether normal inspection procedures are to apply or whether special temporary instructions are to be used until the new supply source has established a quality history.

New item inspection requirements

When a new purchased item is created in ENGINEERING AND PRODUCTION DATA CONTROL, a message is automatically entered into the Quality Control Action File requesting inspection requirements and quality control standards necessary.

The quality control engineer selects the methods of inspection, characteristics to be inspected, sampling sizes, etc., and enters these either by terminal or on an inspection specification form (Figure 31).

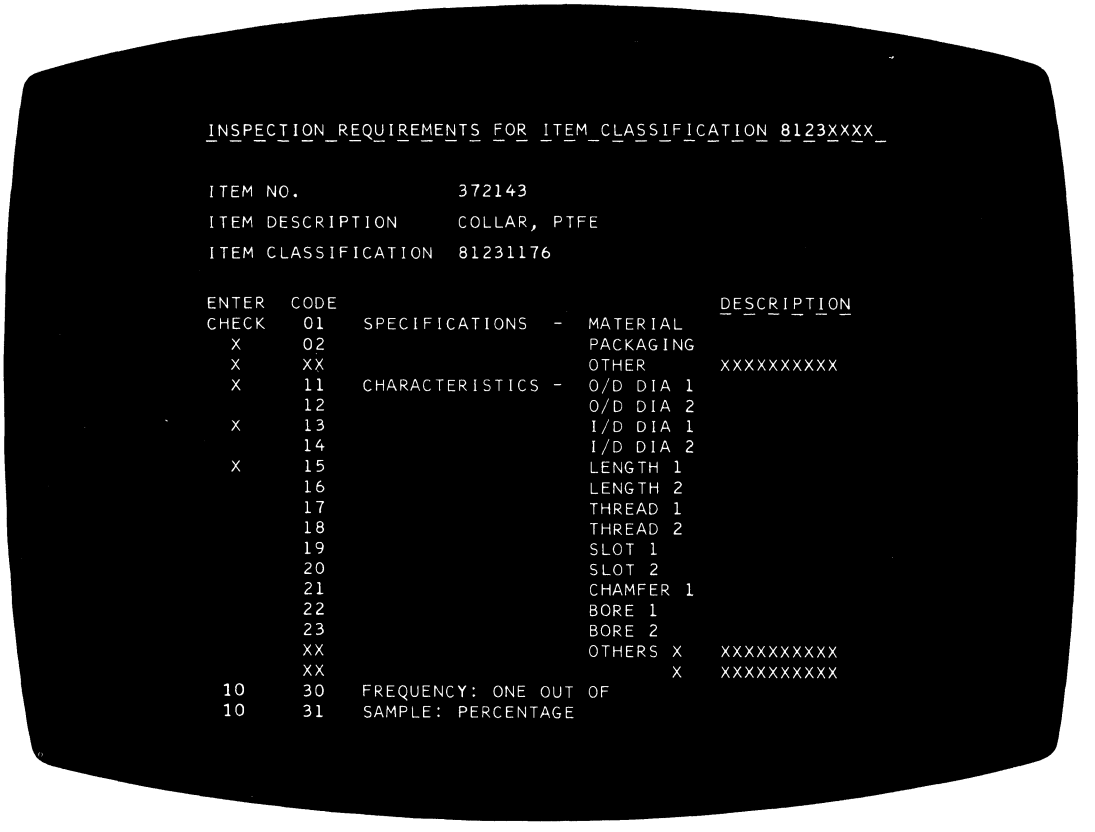
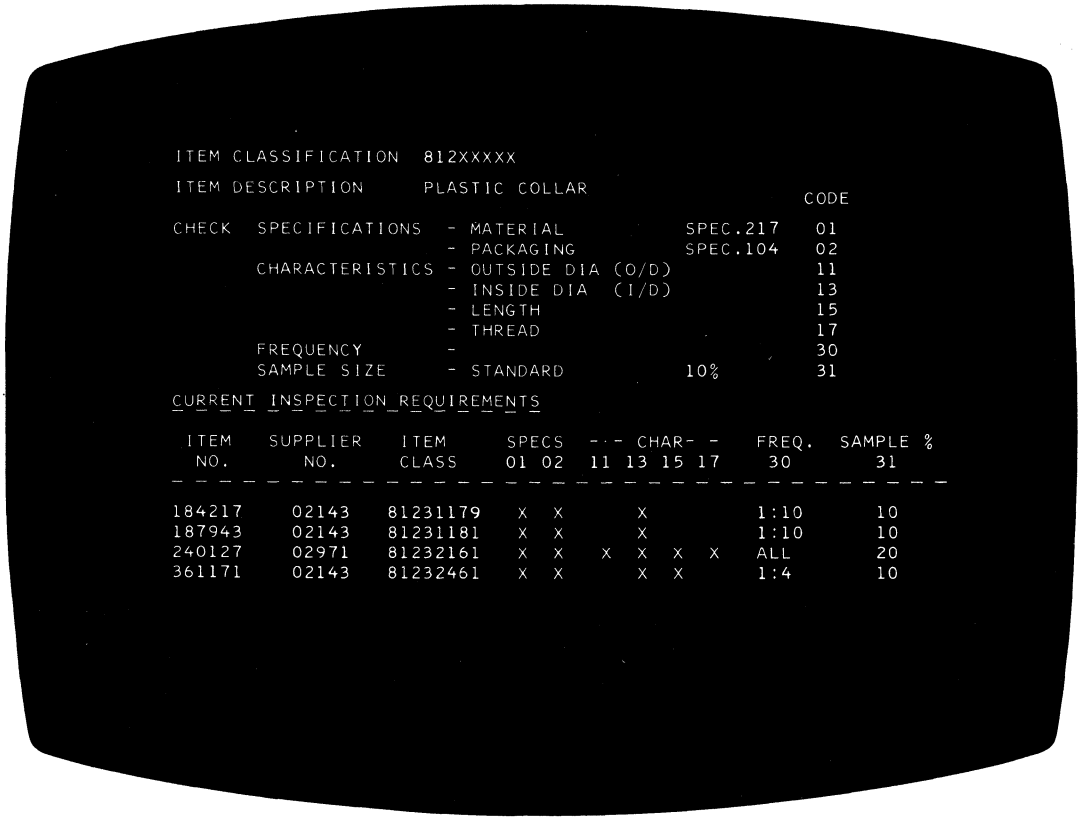


Figure 31. The quality control engineer enters inspection requirements and specifications into the system

Other information to be supplied includes:

- *Where* the items are to be inspected or tested – on the supplier's premises, in Receiving, in special test facilities, on the shop floor, etc.
- The *level* of inspection required – every shipment, every tenth shipment, none
- The *sample* to be tested – 100%, 5%, one in each container, etc.
- *Who* is to test the sample, and whether a particular skill is required
- What *gauges or equipment* are needed for the inspection
- What is the average *time* needed to inspect this item

The system can help Quality Control determine some of these requirements by displaying historical data on suppliers and similar items (Figure 32).



```
ITEM CLASSIFICATION   812XXXXX
ITEM DESCRIPTION      PLASTIC COLLAR
                                                          CODE
CHECK   SPECIFICATIONS   - MATERIAL          SPEC.217     01
                         - PACKAGING         SPEC.104     02
        CHARACTERISTICS  - OUTSIDE DIA (O/D)              11
                         - INSIDE DIA  (I/D)              13
                         - LENGTH                         15
                         - THREAD                         17
        FREQUENCY        -                                30
        SAMPLE SIZE      - STANDARD          10%          31

CURRENT INSPECTION REQUIREMENTS

 ITEM    SUPPLIER    ITEM      SPECS  --- CHAR- -    FREQ.   SAMPLE %
  NO.      NO.       CLASS     01 02  11 13 15 17     30         31
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

184217    02143    81231179    X  X       X          1:10        10
187943    02143    81231181    X  X       X          1:10        10
240127    02971    81232161    X  X    X  X  X  X    ALL         20
361171    02143    81232461    X  X       X  X       1:4         10
```

Figure 32. Information regarding similar items can help determine the inspection requirements for a new item

Inspection Activity Reporting

Items to be inspected usually come into a hold area to await inspection. They are accompanied by the receipt identification card. The materials handler bringing the items to Inspection enters the receipt identification card into a terminal, together with his man number and a location code indicating where the items were stored in the hold area.

The jobs awaiting inspection are maintained on an Action File in priority sequence, the sequence being identical to that described under "Determining Receipts to Count".

Assigning inspection work

Inspection work may be assigned on first-come, first-served basis; that is, when an inspector completes his present assignment, the next job in queue is assigned to him. On the other hand, the assignment may be made by the Quality Control foreman on the basis of skills or testing facilities required. This assignment is accomplished in a manner similar to that of a direct production job assignment (see *Chapter 8, Plant Monitoring and Control*). Briefly, under this procedure, the inspection foreman, using a visual display terminal, reviews the work awaiting inspection and makes assignments by entering the line number of the job against a particular man number. Just as in the case of a normal shop order, equipment and gauge availability is checked before the work is made available for assignment.

Inspection dispatching

The inspector reports completion of his current assignment at a work area terminal (see "Inspection Completion"), and the next assignment is dispatched to him by a printout of the details at the terminal (Figure 33).

```
NEXT ASSIGNMENT                          MAN NO. 3070  F.SMART

P.O.  ITEM   DESCRIPTION  QTY.  SAMPLE   LOCA    --SUPPLIER--
 NO.   NO.                       SIZE    -TION     NO.    NAME
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
02479 179241 NO.3 DRILL  100     20      B 23    20310 ACE MFG

REMARKS:  CRITICAL, NOTIFY  J.BUNN EXT. 307 ON COMPLETION
```

Figure 33. The next inspection assignment is displayed or printed upon completion of the current assignment

By entering a code at the terminal, the inspector can request inspection specifications. These are then displayed or printed, as required (Figure 34). The instructions may cover:

- Sampling techniques to be used
- Characteristics to be checked
- Tools, gauges, or test equipment required
- Any special instructions entered by the quality control engineer, such as unique defect conditions to be checked for, or acceptance at different engineering change levels
- The inspection history on previous lots of this item

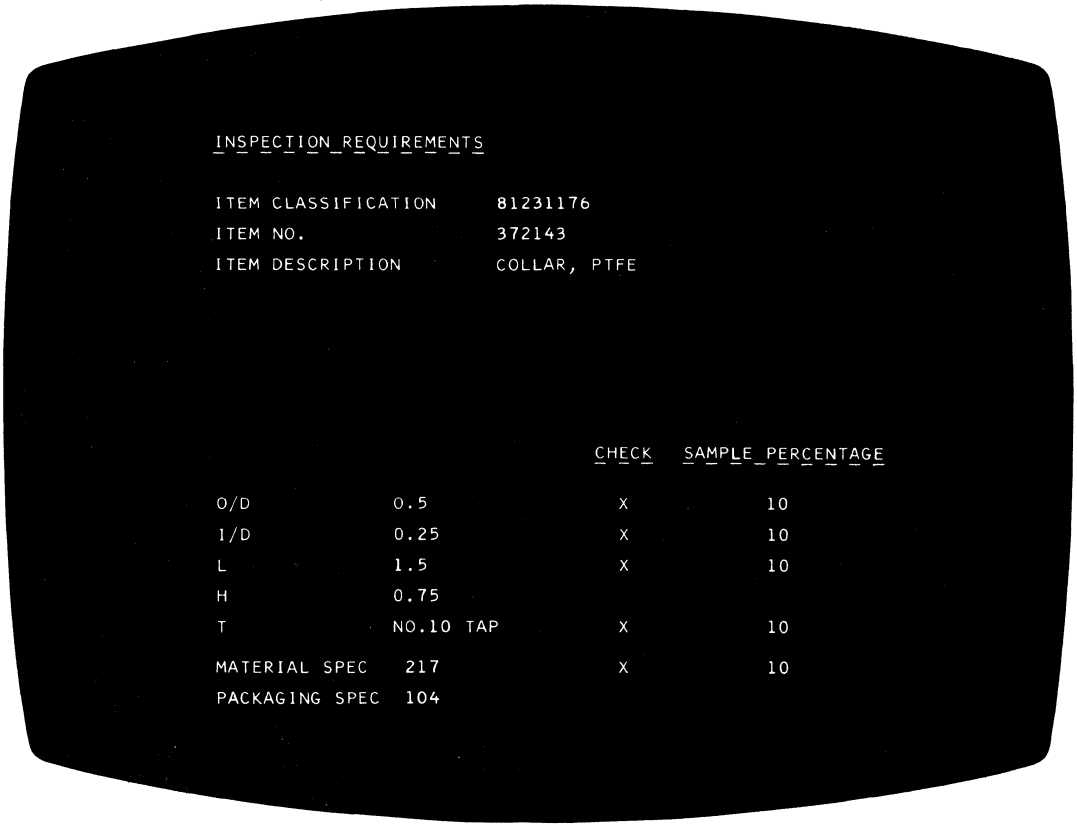


Figure 34. Inspection instructions are displayed upon request of the inspector

Inspection completion

When inspection has been completed (Figure 35), the inspector reports the results via the work area terminal. He enters into the terminal the receipt identification card, a "completion" code, the quantity accepted, and the quantity defective. In addition, by entering a defect code, he can provide the system with the data necessary to develop an analysis of breakdowns by kind of defect.

Defective items go to a reclamation area for a decision as to disposition. The purchase order record for the affected items is updated with the status information. The system generates a reclamation segment of the purchase order record to control the movement and status of the defective lots. This helps Reclamation review nonconforming materials.

When completion is reported, a message requesting a materials handling facility is automatically generated.

The inventory administrator is notified of significant inspection results. If critical parts or items on shortage are rejected, he can notify Reclamation Control that these items should be reworked or, if possible, accepted as off-standard (see "Reclamation Control").

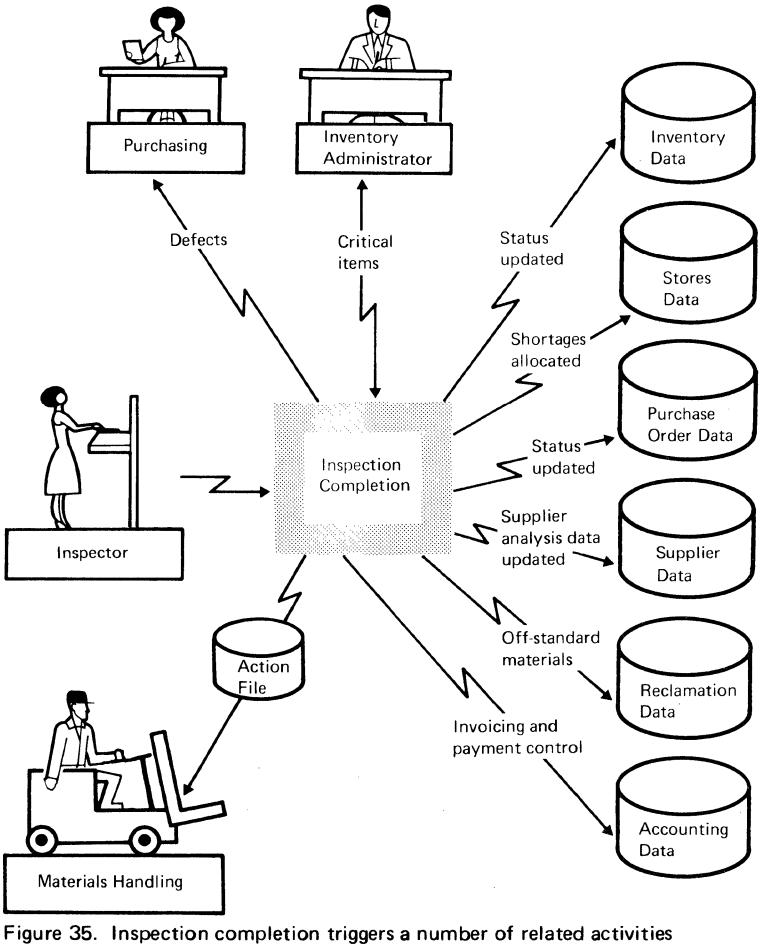


Figure 35. Inspection completion triggers a number of related activities

Reclamation Control

Reclamation Control (or Salvage Control – see Figure 36 for a functional summary) is concerned with maintaining history on defective items and nonconforming material, and with providing data to help determine the disposition of the items. An Action File is maintained for all lots sent to Reclamation Control. These are held in priority sequence.

When the reclamation inspector is ready to analyze the rejected items, he requests a retrieval of the reclamation data by entering into a terminal the receipt identification card, his man number, and a "reclamation" code. This causes a display of all information applicable to the particular lot. It includes:

- Details of the purchase order
- History of previous receipts for this item (Figure 37)
- Critical items, outstanding shortages, and messages from the inventory administrator regarding this shipment
- Rework routings if available

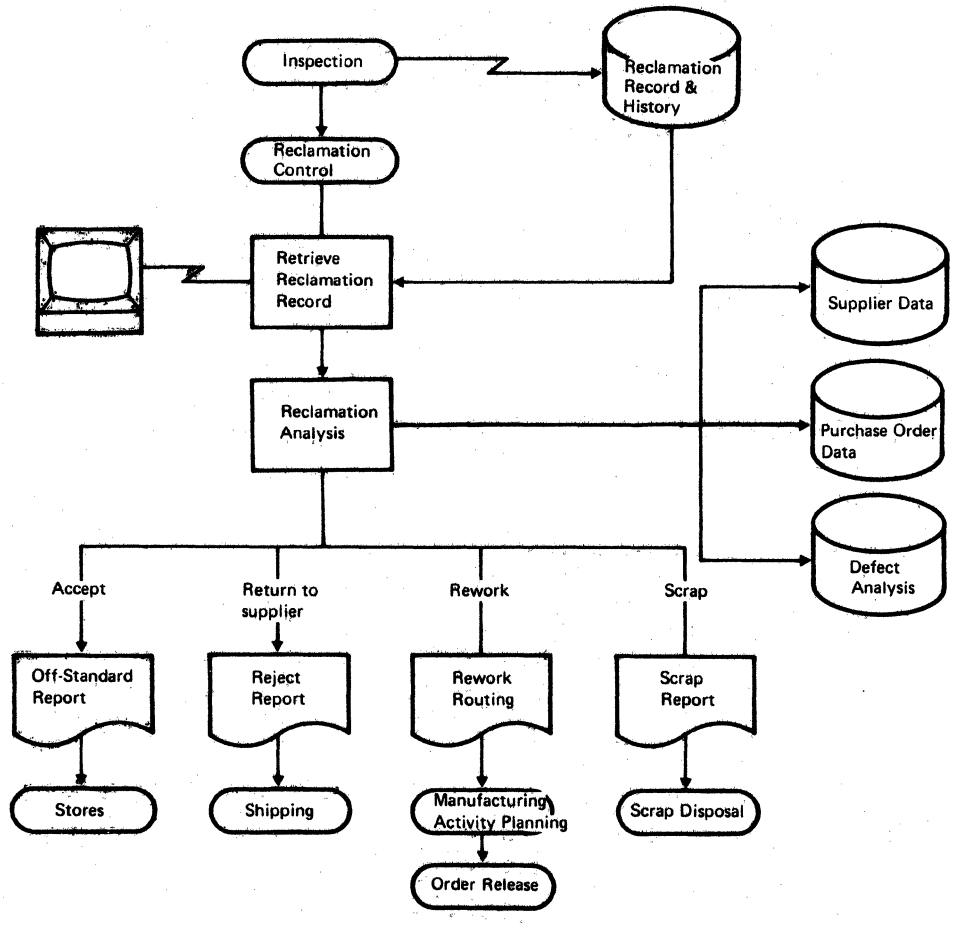


Figure 36. Reclamation Control (or Salvage Control) functions

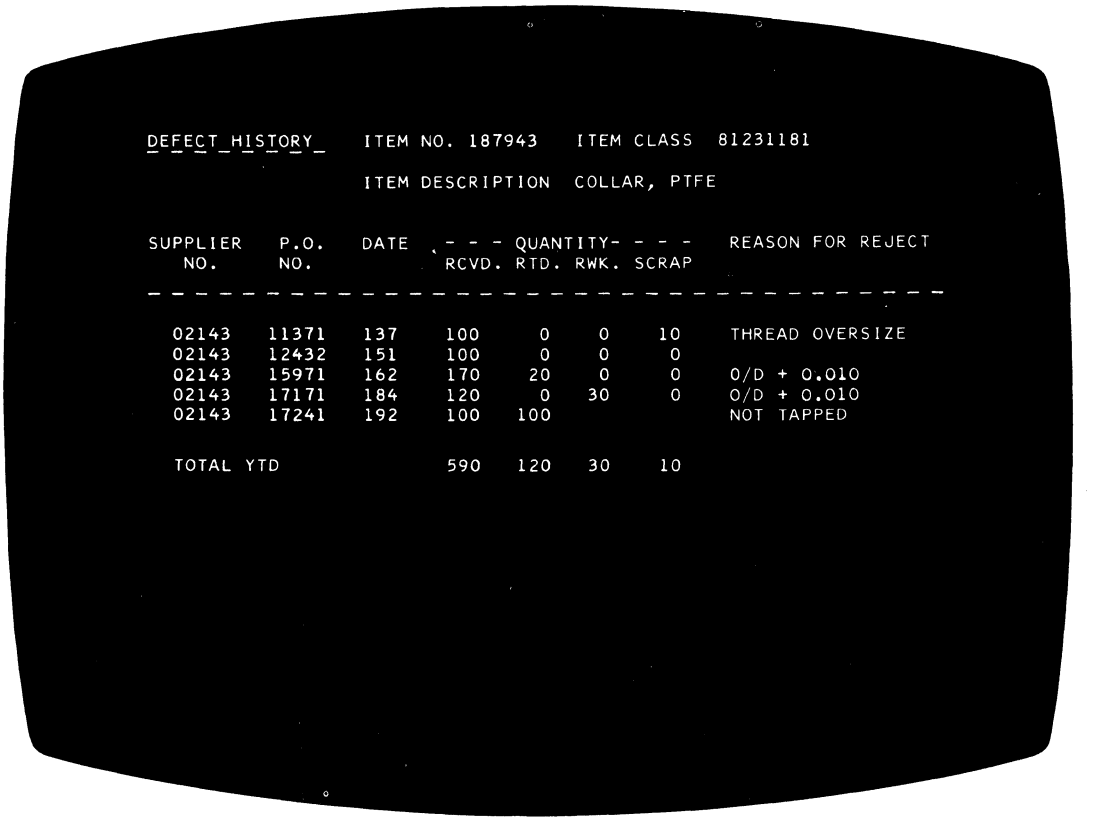


Figure 37. Reclamation Control can request historical information regarding rejected items and nonconforming material

A decision as to the actual disposition may have to be made jointly by Production Engineering, the inventory administrator, Purchasing, and the using department. The system provides a rapid communication medium between them and can display all available data and messages for a decision based on reject history and cost of rework, scrap, and delays to production (Figure 38). The reclamation inspector, however, can make most decisions without reference to outside departments.

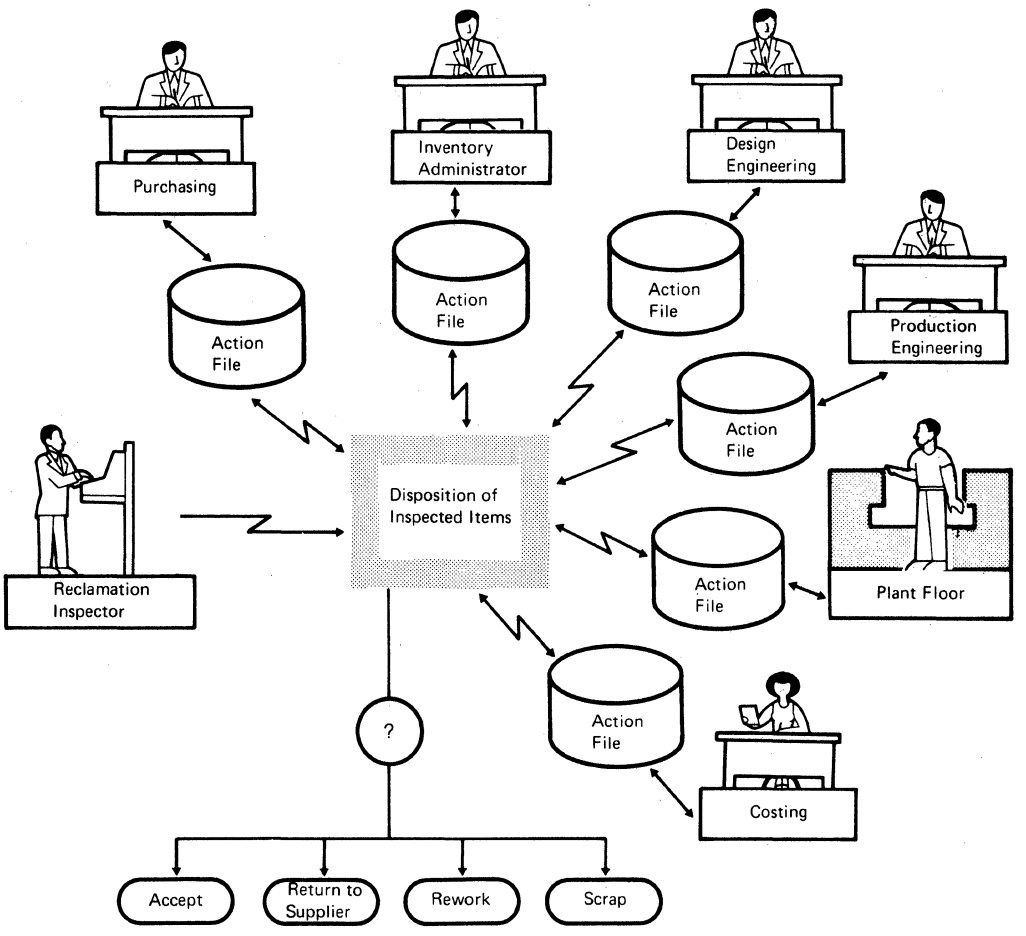


Figure 38. The system can coordinate the various functions concerned with determining disposition of defective items

Disposition of reclamation lots

Basically, the reclamation inspector has four choices in determining disposition of the items:

- Acceptance
- Return to supplier
- Rework
- Scrap

acceptance of off-standard items

Off-standard items may be accepted where they do not affect interchangeability or performance. A record of all receipts of items not conforming to specification can be maintained for later analysis. This may result in a change to the specification if a large number of receipts for the item are off-specification.

The system maintains a notification of the off-standard condition. The items are segregated by STORES CONTROL, and the information is generated as part of shop documentation at order release time.

Most off-standard items are returned to the supplier for correction or replacement. The reclamation inspector enters the receipt identification card into the terminal together with a "return to supplier" code, his man number, the quantity being returned, and the reason for return. The system produces a reject report that accompanies the items to the supplier.

return to supplier

STORES CONTROL is notified of the return so that they can control shipment and shipment documentation. A follow-up report can be generated at a later date by the system to check on progress. A message is automatically sent to the Buyer's Action File for the follow-up with the supplier.

Certain off-standard items may be reworked in the factory – possibly because they are needed quickly, or because they have been damaged in Receiving, or because the supplier has agreed to absorb the rework cost.

rework

A rework order can be entered into the system by the reclamation inspector or production engineer. This creates a record in the Shop Order File to authorize the rework. The procedure is similar to that for entering rework operations in PLANT MONITORING AND CONTROL.

Monitoring and controlling of the rework order is then the same as for a normal shop order. Materials Handling is instructed by the system to move the items to the department performing the first operation.

The rework order and routing is established either by accessing a standard rework routing in the manufacturing routing records or by entering a routing into the system (Figure 39).

Some or all of the defective items may be scrapped. The reclamation inspector notifies the system of this and includes a reason for scrap, a responsibility code, and the disposition. Purchasing and the inventory administrator are notified for any follow-up or emergency action required. A record of all scrap is maintained in the item record for later analysis and reports – for instance, to notify management when the scrap quantity or cost has exceeded predetermined standards.

scrap

Figure 39. A rework routing can be entered into the system by the reclamation inspector or production engineer

Reclamation reports

The following are examples of the types of reclamation reports that can be retrieved by inquiry at a terminal:

- Status of the reclamation "inventory" by item number
- Rework orders issued to date
- Rework status and location
- History of past decisions on off-specification items
- Previous receipts for the item found to be off-specification, and a trace of where those items are now located – either in the warehouse, in work-in-process, or incorporated into delivered products.

Defect Analysis and Control

Defect analysis involves examining item and supplier inspection history for effective feedback and control of inspection specifications and criteria. It is also used for rating the supplier. The defect analysis and control functions are shown in Figure 40.

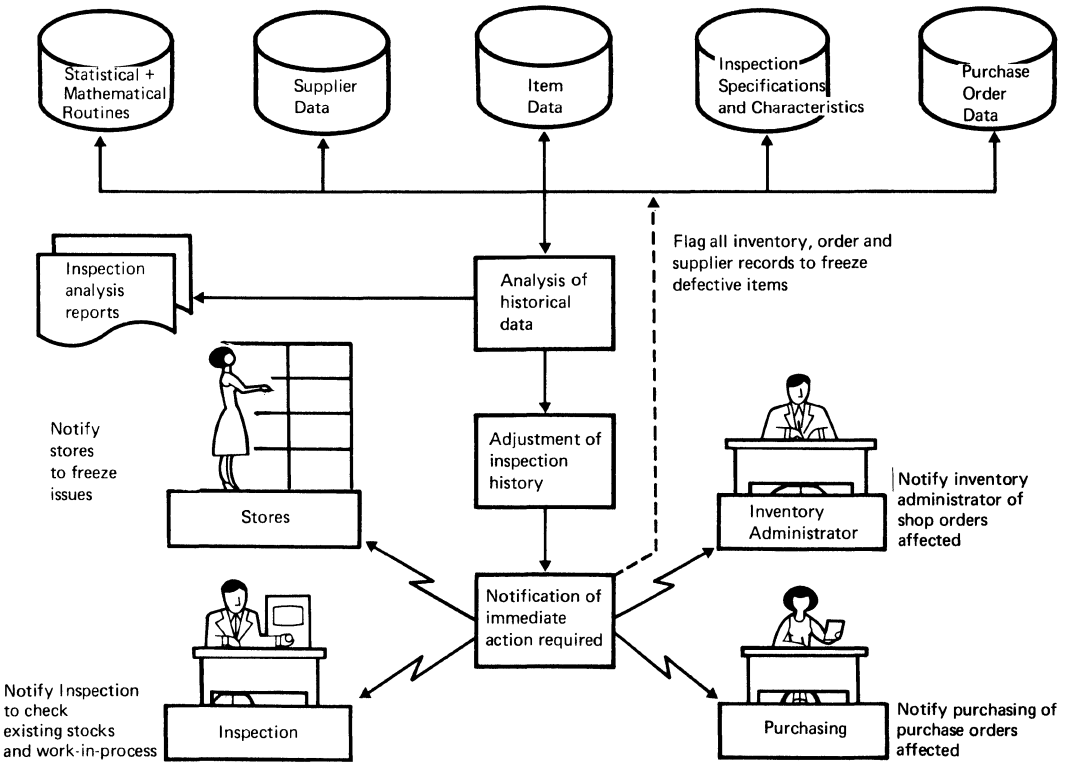


Figure 40. Defect analysis and control functions

Analysis of historical data

Item and supplier history is updated at time of each receipt. Successive occurrences of the same defect on an item, or on a group of similar items or on a characteristic (say, soldering or welding) for a given supplier are checked against established limits. This data helps in analyzing the effectiveness of different suppliers, and in determining where existing specifications should be analyzed to see if changes are needed to inspection specifications.

An example of the type of analysis that can be performed by the system is shown in Figure 41. A monthly report can also be sent to the supplier to notify him of how well he has performed (Figure 42).

QUALITY CONTROL - SUPPLIER SHIPMENT SUMMARY PERIOD 201-221

VENDOR NO.	SHIPMENTS	INSPECT	RECEIVED QUANTITY	ACCEPTED	OFF-STD	RETURNED	RE-WORK
0001	2	2%	32000	100%	0%	0%	0%
0320	63	5%	251831	91%	1%	8%	0%
0412	1	10%	400	100%	0%	0%	0%
0505	1	5%	40000	100%	0%	0%	0%
0660	108	1%	127388	99%	0%	1%	0%
0805	2	5%	6713	100%	0%	0%	0%
GRAND TOTAL	SHIPMENTS 177		458332	434717	2325	20583	1432
TOTAL PERCENTAGES				95%	1%	4%	1%

Figure 41. Supplier evaluation is based on information developed by QUALITY CONTROL

automatic adjustment of inspection frequency

As a result of the correlation of current data from Purchase Quality Control with the inspection specifications on file, the system can automatically modify the frequency of inspection or the sample size. For instance, a favorable history may mean reducing the inspection requirement from checking every shipment to checking every tenth shipment. This lightens the inspection load considerably, with little or no loss of quality. Should the defect rate start to increase, the system automatically adjusts the inspection requirements for new shipments.

Major quality problems may require fast action to stop further shipments from the supplier or to "freeze" existing stocks. When the inspector enters a "stop" code on a particular item, the system reacts by:

- Flagging all receipts for similar items to prevent their movement to stores
- Flagging all on-hand quantities to prevent issues from being made
- Generating Action File messages to Purchasing, the inventory administrator, and Manufacturing Quality Control to initiate action.

QUALITY CONTROL - SUPPLIER SHIPMENT REPORT - MARCH

FOR THE ATTENTION OF

A. SUPPLIER 03204
QUALITY WORKS
MIDLAND CITY

DEAR SIR,

THE FOLLOWING LIST SHOWS ALL THE PARTS YOU HAVE SHIPPED TO US DURING THE ABOVE MONTH, AS WELL AS OUR DISPOSITION OF EACH SHIPMENT. WE HOPE THIS INFORMATION WILL HELP IN YOUR CONTINUED EFFORTS TO SUPPLY US WITH ACCEPTABLE PARTS.

J.D. SMITH
INSPECTION DEPT.

ITEM NUMBER	EC LEVEL	ORDER NUMBER	SHIP. DOC. NO.	DATE RECEIVED	RECEIVED QUANTITY	ACCEPTED QUANTITY	OFF-STD. QUANTITY	RETURNED QUANTITY	RE-WORK QUANTITY
2899	60486	22479	00027840	3/4	47000	47000			
11605	60486	22624	00027765	2/27	1750	1750			
24934	10016	22554	00027888	3/16	19000	19000			
171599	62029	22671	00027766	2/27	5500			5500	
212900	61651	23193	00027770	2/26	150	150			
227854	60592	21837	00027854	3/16	6400	6400			
227890	1612	22903	00027771	2/27	10600	10600			
227903	3528	19816	00027725	2/20	2200			2200	
227903	3528	22872	00027852	3/16	2200	2200			
227903	3528	19816	00027851	3/16	300	300			
227929		21500	00027892	3/16	2510	2510			
227970	62036	24506	00027866	3/16	19500	19500			
228036	605922	22876	00027769	2/27	18900	18900			
228044	3404	23476	00027845	3/16	7840	7840			
228067	1612	22547	00027724	2/20	19684	19684			
228418	61722	18856	00027753	2/20	1655			1655	
228418	61722	18856	00027815	3/4	400			400	
228418	62069	21649	00027816	3/6	910			910	
228418	62069	21649	00027884	3/9	2300			2300	
228475	61029	19154	00027513	3/4	11000	11000			
300494	61100	22789	00027767	2/27	6800	6800			

Figure 42. Periodic reports can be developed to help suppliers evaluate their quality performance

The system automatically provides data on all:

- Purchase orders, so that Purchasing can notify suppliers of the problem
- Affected shop orders, so that the inventory administrator can check existing work-in-process
- On-hand quantities and bin locations, so that stores inspection can check or withdraw all stock (see *Chapter 11, Stores Control*).

Inspection workload planning

The workload on Purchase Quality Control can be determined from an analysis of:

- Receipts in process awaiting inspection
- Lots awaiting reclamation inspection
- Purchase orders
- Inspection specifications and criteria for the items

A manpower workload report can be generated showing the workload based on current receipts and the expected workload over the next few weeks. If time standards are available for inspection, this can be in terms of man-hours; if not, in terms of number of jobs or pieces.

Through an analysis of the individual characteristics that require inspection (such as need for special test equipment), a machine load report can also be generated.

Inspection workload is discussed further under "Manufacturing Quality Control" in *Chapter 8, Plant Monitoring and Control.*

Quality Control reports and standards

The system can assist Quality Control management also by producing various briefing reports. These reports and the statistical techniques used by the system allow inspection standards to be determined for improved efficiency and control of quality.

- Reports based on receipts-in-process data, such as present inspection lot status, inventory levels, and average "lead time" from receipt to completion of inspection.
- Reports on test equipment usage, manpower efficiency and performance, through analysis of the time spent against predetermined standards or historical averages.
- Quality cost reports, such as cost of scrap or reworked items relative to purchase cost, and recovery costs from suppliers for returned material and reworking of defective items.

Summary

Purchasing controls orders for purchased items, from availability of the requisition to delivery. It simplifies and speeds the ordering process, so that more buyer time is available for important buying decisions, with the aim of reducing prices, late deliveries, and quality rejects.

Supplier and quotation data maintained in the system is readily available to help the buyer compare and evaluate alternative suppliers. Supplier performance in fulfilling orders is monitored continuously. Quality, delivery, and price performance are measured, and from this information the system develops supplier ratings so that a recommended supplier can be selected for each order.

Action Files are used to present purchase requisitions to the buyer in priority sequence. For low-value orders, automatic supplier selection and purchase order generation relieve the buyer of much repetitive work, enabling him to concentrate on large-volume and high-value items. He can review the system-generated dates, quantities, and supplier selections, so that his more detailed knowledge can be used when changes are necessary.

Much of the purchasing department's routine clerical work is performed by the system. Quotation renewal, as well as acknowledgment and expediting of orders, is automatically initiated and controlled.

Statistics developed from the purchasing data enable the purchasing department workload to be planned, and the performance of buyers and buying teams to be compared. From purchase orders placed, the cash requirements for accounts payable can be developed for the financial executive.

The RECEIVING function involves processing and controlling receipts from the time of delivery until the material is stocked or distributed. The coordination function performed by RECEIVING significantly reduces the elapsed time from receiving to stores. This, in turn, reduces inventory and frees space in the receiving department. Critical material is delivered to the correct area much faster. Where documents or information is missing, the system provides extensive information to help identify the receipt.

The inventory administrator and purchasing department are notified immediately upon receipt of critical items and shortages. The inventory administrator can put the disposition of critical items directly under his control for distribution and allocation to clear shortages.

The system indicates which items are to be counted. It also indicates which shipments and quantities are to be inspected. Historical data is analyzed and used to automatically adjust the frequency of inspection and counting.

PURCHASE QUALITY CONTROL provides quality information to Purchasing to help in selection of suppliers. It also determines the inspection specifications and criteria needed for incoming receipts.

Inspection work is assigned and dispatched according to the current status of the receipts, thereby ensuring that urgent jobs are cleared first. Rejects are sent to Reclamation Control, where the disposition of the off-standard items is determined.

The workload on the receiving and inspection departments can be planned on the basis of a knowledge of receipts and purchase orders.

The reduced receiving and inspection lead time, along with the improved control and coordination of the receiving functions, considerably reduces the operating costs of these functions while providing improved information to management.

Chapter 11. Stores Control

Contents

Introduction

Too often in the past, inventory control systems have failed to live up to their potential because they have not taken into account the physical aspects of warehousing, that is, characteristics such as weight, volume, perishability, physical location, etc. STORES CONTROL considers these physical aspects in receiving, storing, and issuing inventories used by other areas of the system. In conjunction with INVENTORY MANAGEMENT, in which inventory is treated as sets of items measured in terms of quantity or value, STORES CONTROL is designed to provide a comprehensive inventory control capability.

What is supposed to happen in stores and what actually happens are often two different things. Unless the "unofficial" procedures and systems are recognized and brought under control, any type of materials planning system will fail. The existing system must be overhauled to achieve the operating standards necessary for accurate inventory accounting.

stock categories

The term "stores" or "warehouse" is used here in its broadest sense and includes all kinds of physical inventory locations in a manufacturing organization. It does not differentiate between types of stores and contents, nor does it distinguish between a finished parts warehouse, subassembly stores, tool stores, etc., except where explicitly stated.

Functions of Stores Control

This chapter contains a discussion of the major physical and recordkeeping aspects of receiving, storing, and issuing stocked items (see Figure 1):

- "Establishing Basic Disciplines" describes the basic disciplines necessary for effective control over physical inventories. Improved transaction and documentation control, stock checking, and identification of responsibility for transactions provide the level of accuracy necessary to support the remainder of the system.
- "Location Control" discusses how item characteristics are matched to appropriate stores facilities with the aim of improving space utilization, labor productivity, and speed of turnaround in the warehouse.
- "Order and Requisition Filling" deals with improving the efficiency of physical warehouse activities and reducing the number of unplanned and unauthorized movements.

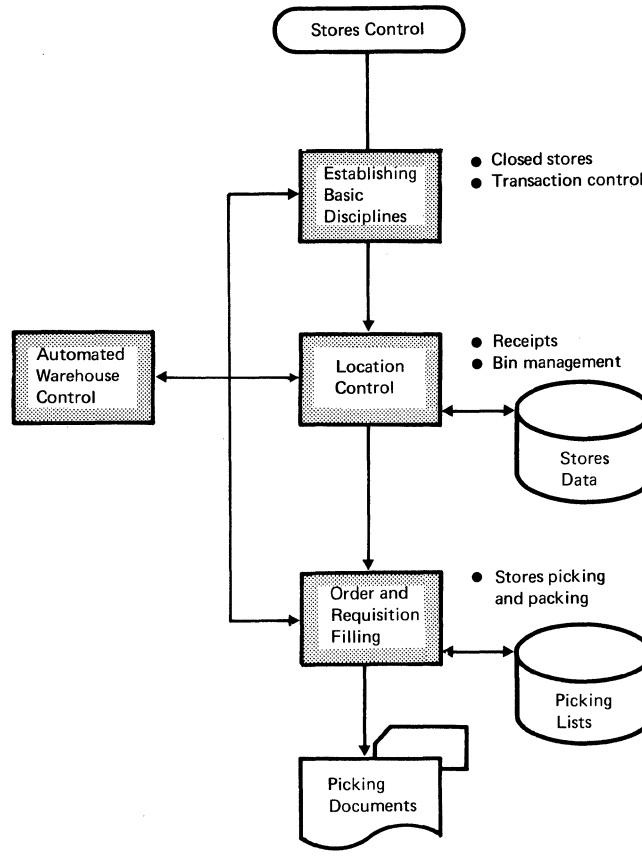


Figure 1. Functions of Stores Control

- "Automated Warehouse Control" discusses the application of a computer-based system to automated warehousing. This approach enables the full potential of this storage method to be realized, including the elimination of manual errors, improved item location, and increased warehouse utilization and throughput.

Relationship with other application areas

As Figure 2 indicates, STORES CONTROL is related to virtually all the other application areas of the overall system:

- ENGINEERING AND PRODUCTION DATA CONTROL maintains the basic item records, including item classification by size, weight, shape, etc., which is used to determine the type of bin storage required.
- CUSTOMER ORDER SERVICING determines the customer delivery date and provides shipping dates, shipping documents, and requisitions.

- INVENTORY MANAGEMENT determines the level of inventory to be held in stores and plans movements into and out of stores on the basis of production schedules. All receipts, issues and adjustments are reported by STORES CONTROL to update the inventory data. INVENTORY MANAGEMENT also requests physical stock counts based on predetermined criteria.
- MANUFACTURING ACTIVITY PLANNING determines the load on the warehouse on the basis of calculated order release dates and dates on which orders are due in stores. It also determines the priority used in establishing picking sequence.
- ORDER RELEASE prepares material and tool requisitions for issue to the plant floor. Consigned materials are requested for purchase orders. STORES CONTROL prepares picking lists from the requisitions.
- PLANT MONITORING AND CONTROL provides information on all manufacturing shop orders being delivered to stores. Material and tool requisitions for additional items and materials may be requested via terminals on the shop floor.
- PLANT MAINTENANCE determines the requirements for maintenance spare parts. The procedures are the same as for production items.
- RECEIVING notifies STORES CONTROL of all receipts from outside suppliers.
- COST PLANNING AND CONTROL calculates the cost of all transactions into and out of stores.

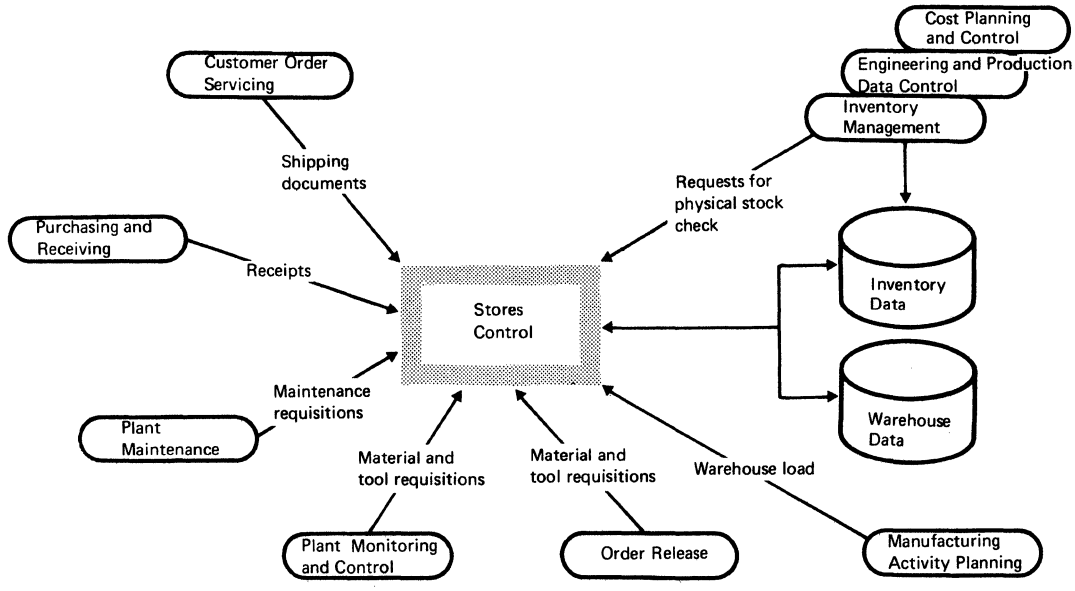


Figure 2. Relationship with other areas

The use of computers for inventory control has often highlighted weaknesses in existing warehousing systems. Procedures have many times been modified for the convenience of operating personnel, so that they no longer fulfill their original aims. An example is the way in which bin cards, originally used by storekeepers to record the contents of bins, have frequently been made the responsibility of production control departments.

The following requirements, however, are fundamental to effective inventory management.

Closed Stores

Stores must be protected from intrusion by unauthorized personnel by whatever means necessary, including fences and locks. Most violations of "open stores" are committed by production people who need something when the stores are not manned. There is no concern with paperwork, but only with producing parts. Consequently, if the stores are open, production workers will make unauthorized withdrawals – for example, to ensure that they will still have material to work on during the following shift, or to replace scrapped material. In doing so, they overlook several important points:

- There may be a higher-priority contender for the stock concerned.
- The likelihood of an accurate recording of unauthorized withdrawals is small.
- The wrong parts or material may be withdrawn.

Objections to closed stores

The main objection to closed stores is that the number of storekeepers must be greatly increased to provide continuous service, even though they are not actually busy for more than a fraction of their time during night shifts or on weekends. However, companies have overcome this objection by:

- Having fewer and larger stores. This enables more effective use to be made of stores personnel, even at slack times. It also means, however, that stores may be situated less conveniently to the using departments, but the preplanned issuing procedures discussed later help to offset this. Planned issues for second and third shifts can often be made during prime-shift time, so that only exceptional issues (say, because of scrap) have to be made at other times. These can be handled by a limited number of stores personnel.

When stores are concentrated into fewer and larger units, the benefits of automated warehousing techniques can be more easily obtained, since the increased volume of work at each location can justify the automation and computer control.

- Making greater use of bulk issues to "floor stock" for large-volume and low-cost items, that is, carrying a buffer stock of these items to cover demand for the next few days or weeks. Replenishment is made only at infrequent intervals.
- Scheduling the storekeeper's task in the same way as production workers' tasks, to ensure productive use of these men at all times.

Reducing the number of stores

In many organizations a major problem affecting the number of stores is the contention between those responsible for satisfying customer demand and those whose task it is to keep assembly operations supplied. "Production robbing spares" and vice versa is a common result of this problem. A solution often adopted is to employ separate stores, not for any operational reasons, but so that the two organizations can replenish and issue materials independently.

This approach of having multiple stores for the same items results in duplicated functions, facilities, and manning, and in greater total inventory. Provided that competition for parts in short supply can be resolved and that the stores disciplines referred to earlier can be maintained, combined stores will work satisfactorily, without any duplication or increase in inventory.

Reduced number of shortages

With a sounder approach to inventory management in general, the incidence of material shortages causing contentions is reduced. Shortages can never be eliminated, because of late deliveries, unusually high customer demand, or unexpectedly high scrap, for which the safety stock is inadequate. However, the impact of shortages can be reduced through a system which immediately informs Production Control regarding receipts of shortage items and which provides immediate information as to the disposition of the items to clear the shortage.

INVENTORY MANAGEMENT handles contention between different requirements for the same bin stock. Handling of critical purchased items is discussed under "Receiving" in *Chapter 10, Purchasing and Receiving.*

Transaction Control

The need for close control over transactions has been stated under "Inventory Accounting" in *Chapter 5, Inventory Management.* This, together with control over the warehouse facilities described under "Closed Stores" earlier in this chapter, will ensure a sound basis for MATERIAL REQUIREMENTS PLANNING.

Authorizing certain people to make withdrawals, editing transactions as they occur, verifying stock balances, and identifying the stores personnel responsible for making particular issues and receipts, all help toward effective control. These are discussed in the following pages.

Authorizing issues

Most issues are planned by the system, and requisitions are produced automatically by ORDER RELEASE. However, it is never possible to cover every contingency. For example, there are often unplanned requirements because of excess scrap, or because of maintenance personnel wishing to use normal items to test a repaired facility.

Only certain individuals must be authorized to make these unplanned withdrawals. If unallocated inventory is available, the system permits unplanned issues when an authorized individual makes such a request at a terminal. If the request is for an issue greater than allowed for in the forecast for such miscellaneous demands, it is reported by Action File to the responsible inventory administrator so that its impact on future availability of the item can be considered. The issue may be approved or stopped, depending on the priority of other orders for the same item.

Stores transactions

Every transaction must be recorded as soon as it occurs. This principle is too often disregarded in practice. The consequences of delay are:

- Posting of the transaction is completely forgotten.
- Posting is done incorrectly.
- Out-of-date records remain so for longer than necessary.

Delay results in on-hand inventory appearing to be greater than it really is, and may result in late ordering of some items. STORES CONTROL uses terminals for recording entry of issues and receipts, and ensures immediate recording of transactions. Use of these terminals reduces the amount of data to be recorded by the storekeeper, provides an immediate check on the validity of the entry, and virtually eliminates transaction errors.

Physical stock checking

Techniques for physical stock checking have been discussed in *Chapter 5, Inventory Management.* Stock checks should always be actual counts and not guesses. Whether physical inventory is checked on a continuing basis or periodically, it is useless unless the check is in the form of a physical count or weight. When unrealistic checking schedules are created, or checkers are diverted to other tasks, it is not uncommon for "stock check" figures to be, in fact, reported from a bin card record, or by estimate, instead of from a physical count.

From the company's point of view it would be better if no estimate of stock availability were made at all, because such an estimate gives entirely unjustified confidence if it agrees with the system records, and may cause last minute shortages and unnecessary reconciliation work if it does not agree.

In this system, planned stock checking tasks are displayed on terminals in Stores (Figure 3), and results are reported to the system through the same terminals (Figure 4). Stores management can also request an unscheduled stock count when discrepancies appear.

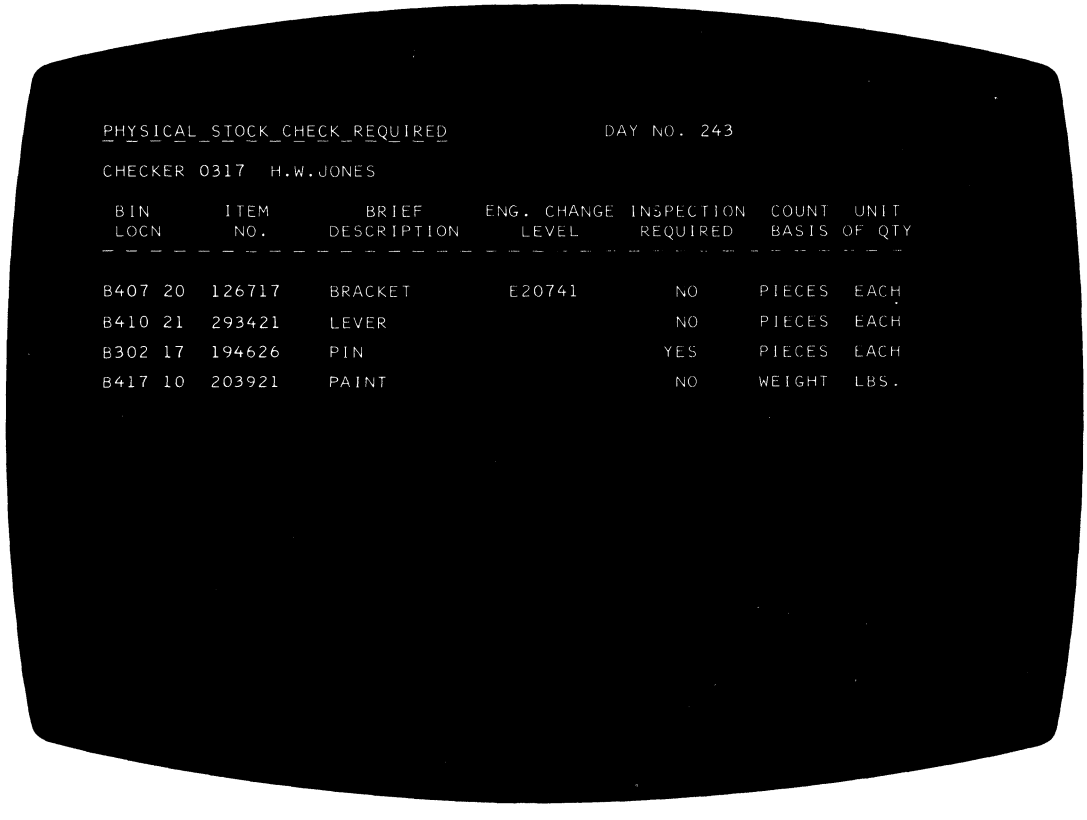
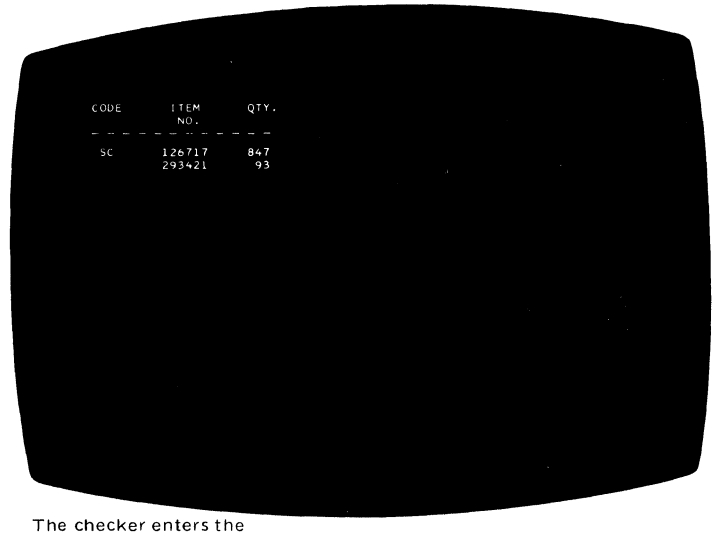
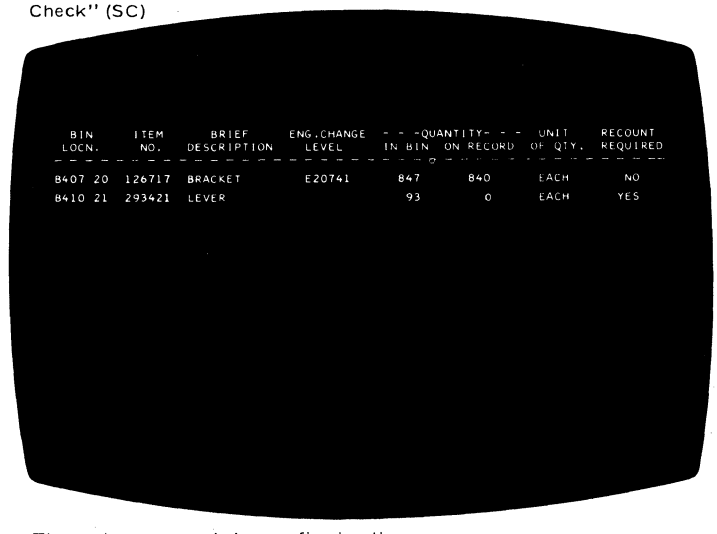


Figure 3. Requests for a stock check can be displayed on terminals located in stores

Stock checks normally involve quantities only. In some industries, however, there is a clear need for a check on the actual nature of the items in bins, and some audit should be made of this. For example, when items are subject to deterioration or have a limited shelf life, the item record in the product definition data base contains the deterioration rate and the expected shelf life expiry time. The need for verification by Quality Control can be included on the physical stock checking schedules created by the system.



The checker enters the item number and quantity checked together with a transaction code "Stock Check" (SC)



The system responds by confirming the count if it is within allowable limits. When the count is outside these limits, a recount is requested.

Figure 4. The checker enters the quantity in the bin, and the system responds by confirming the count or requesting a recount

Inventory accounting is based on item number. In STORES CONTROL, however, the basic key is a bin number. The basic resource this system manages is a single, indivisible unit of storage. This storage unit may take many forms – for example:

- One cell in a bank of shelving (as for small items)
- One storage vat (as for oil)
- One location in a large field (as for castings and forgings)
- One position in a rack (as for tube and bar stock)
- An area marked out on the plant floor

For convenience each of these units will be described as a "bin", but it should be remembered that the word covers all types of facility. Similarly, the word "item" is used to cover all those things placed in bins – end items, subassemblies, manufactured and purchased components, raw materials, supply items, tools, fixtures, etc.

It is fundamental to STORES CONTROL *that no bin is ever associated permanently with a given item number,* except where the nature of the item requires a specific physical storage facility, as in the case of liquid oxygen tanks.

The advantages of this freedom from fixed locations are the ability to:

- Cope with variations in stock quantities without wasting bin facilities (oversize bins need not be used to allow for increases in stock level)
- Cope with continuing changes in the mix of items stocked (that is, as old items are obsoleted and new ones added)
- Assign items to bins in such a way as to expedite picking
- Maintain effectively the lot or batch identity of groups of items
- Manage the consumption of items on a first-in, first-out basis
- Reduce the risk of items becoming mislaid
- Monitor occupancy by type of bin, so that the need for extra capacity is recognized in advance

In addition, the system can optimize bin usage so that fewer bins are required. Where cost and effort do have to be expended is in coding the size and location of the bin, as well as the dimensions and storage requirements of each item. This allows the system to assign items to bins correctly.

Item definition

To be able to make proper, if not optimal, assignment of new receipts to bins, it is necessary to know the characteristics of the items concerned. Certain characteristics are coded in the item record and others are calculated and stored by the system. Included is such information as:

Weight

Dimensions, or space occupied, for storage purposes

Fragile or not

Quantity in unit pack

Need for special environment, such as controlled temperature, humidity, or inflammability

"Pilferage" indication (items like radios, small tools, valves, etc.)

Frequency of movement in or out

Shelf life

For automatic bin assignment all items must be coded in one form or another. When item storage facility codes are not found in the product definition, STORES CONTROL uses the item classification code. This code is adequate when the bin type is not critical, as in the case of small items like rivets, screws, washers, etc.

Facility definition

For each bin definition the following information should be considered:

- *Environment of store* – whether air-conditioned, dust-controlled, subject to special security, or used for non-duty-paid items (customs bonded) that will be re-exported; whether assigned to specific customer or contractor such as an equipment installer or maintenance contractor; how many shifts manned; and location – that is, a grid reference pinpointing the location of each bin.
- *Characteristics of the bin* – maximum weight allowed, type (shelf, vat, rack), maximum reasonable dimensions of items to use it, physical location on grid plan, ease of access (for example, ladder needed?), number of bins of this type, proportion of the bin that is free, list of items to which a special purpose bin or vat is restricted - for example, cyanide for heat treatment.

The facilities for data base design and management (described in *Chapter 1, Engineering and Production Data Control* and *System Data Base*) are also used to control stores data, which is considered as part of the facilities data base. In Figure 5, the item record indicates the bin number, which is used to locate the bin record describing the location where the item is stored. The bin type record is a cross reference of the available and occupied bin facilities, and is used when assigning new bin locations.

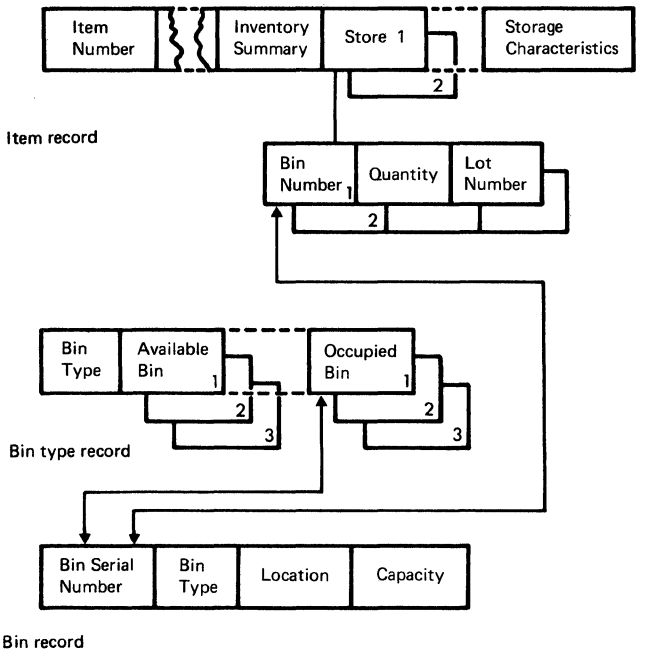


Figure 5. The stores data in the facilities data base relates item characteristics to available storage facilities

Nonproduction and tool stores

In location control, the treatment of supply items and standard tools differs very little from that of normal production items. Tools that are reusable have a greater proportion of unplanned issues and, therefore, may be grouped together in bin locations. Often, however, there is a need for permanent assignment of tools to specific bins. For instance, many tools require specifically made stands or shelves (for example, broaches), while dies are so varied in shape and size that they typically stand on the floor. In the latter case, a "bin location" by grid reference can be an aid in very large tool stores. The grid reference is reported to the system when the tool is returned from production.

Bin Management

By relating bins to the items they contain, stores data provides a dynamic capability for stores location control. Online recording of transactions enables the bin management capability to operate effectively. Only by this means does location control avoid assigning new stock to a bin already full or directing a stock picker to an empty bin.

The actual data maintained by the system to record the occupancy of a bin may include:

Item number stored there

Quantity

Supplier and order and batch or lot numbers

Engineering change level

Dates of receipt(s) and issues, and identification of storekeepers responsible

Other bins containing this item

Method of issue (such as first-in, first-out)

Whether material is off-standard and can be issued only on special request

Whether the items in this bin have been "frozen" by Quality Control *pending inspection*

Bin selection

In the case of receipts due from Receiving (purchased, subcontracted, or interplant items), Stores is notified by Receiving; in the case of receipts due from Production, the notification is from PLANT MONITORING AND CONTROL. For unplanned receipts, such as items returned by the toolroom after a jig has been tested, the storekeeper uses a direct entry at a terminal to obtain a bin assignment.

The assignment occurs before items are moved away from their current location in Receiving or Inspection. Consequently, bin selection is already made before items arrive at the stores. The logic of bin selection is shown in Figure 6.

Once a bin has been selected, as much stock is assigned to it as its capacity allows, and a record of bin occupancy is automatically created. If some stock is still not allocated, the above process is repeated, with the aim of selecting bins near one another for non-automated warehouses. (When utilizing automated warehouse equipment, it is not usually advisable to put all of one item in the same aisle, since access to the aisle may be cut off, for example, when the stacker crane breaks down.)

The logic can be varied to achieve specific objectives. For example, receipts can be first spread over bins already holding the item in order to conserve bins, or a new bin can be selected so as to avoid mixing batches and ensure stock rotation.

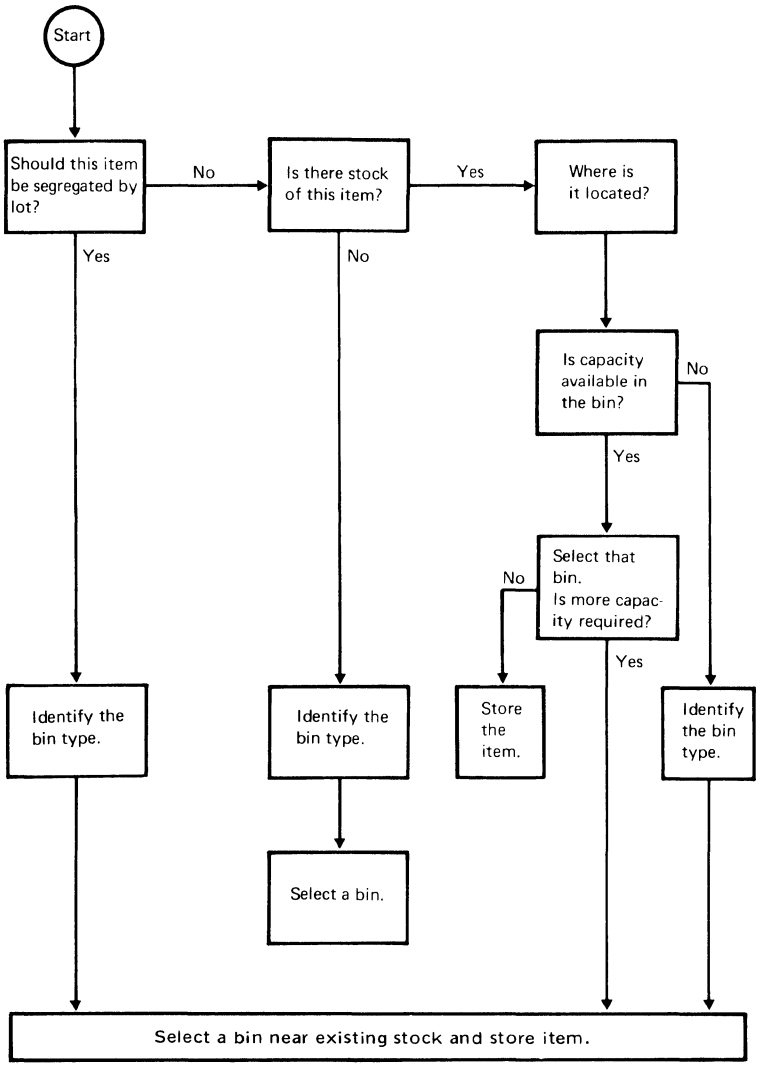


Figure 6. Bin selection logic is aimed at assigning to one place as many as possible of a particular item

Bin cards and stock record cards

Bin cards, historically, have been simple visible record cards physically attached to bins and having columns for receipts, issues, and remaining balance. The value of such a record has been that the storekeeper could tell at a glance whether sufficient stock was available to meet a requisition.

This value was diminished when the bin cards were removed from the bins and put into binders or files as stock record cards. Movements were posted to these cards not at the time of transaction, but later, when work was slack, and so the advantages of immediate transaction recording were lost. Subsequently bin cards or stock record cards were removed from the stores altogether, combined with ordering

information, and placed in production control departments. This arrangement offered the advantage of a combined central record, but it also meant that the bin or record cards were never up to date with actual stores transactions.

In many cases this resulted in both a bin card being held in the bin itself to check the latest position, and a stock record card being held centrally for planning and control. This, in turn, resulted in duplicate recording and more chance of error.

In the system being described, there is no requirement for bin cards or stock record cards.

Terminals Replace Manual Records. Inquiry into system records via a terminal offers a better capability than the original bin card because:

- Individual bin records can provide the number, description, and quantity of the item using the bin.
- Item records indicate the location of every bin in which the item is stored, with quantity, date stored, and date last counted.

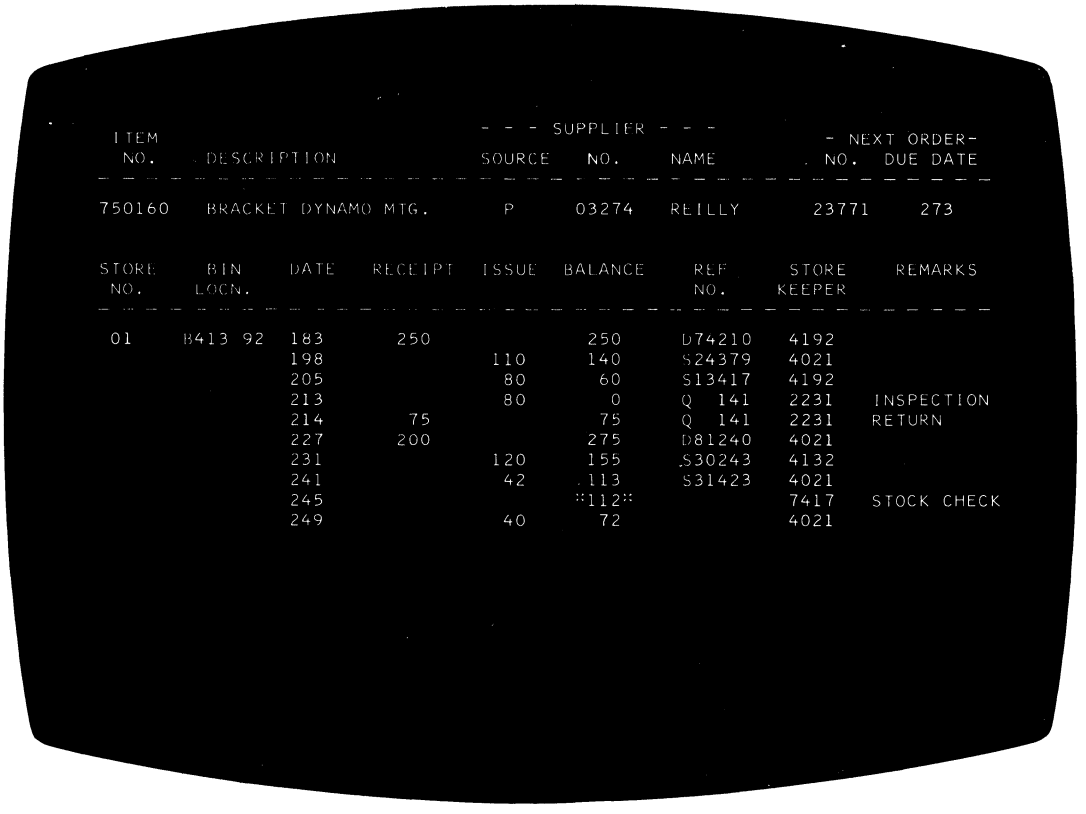
This information, which is more comprehensive than that of the original bin card, can be obtained on demand.

Because of closer control over stored items, problems such as insufficient bin stock seldom arise. When problems do occur, however, a full inquiry capability is available at the nearest area terminal. Figure 7 illustrates a typical display in reply to an inquiry.

A terminal-oriented system in Stores offers all the advantages and convenience of the bin card, the benefits of central planning and control to react to changes in the materials plan, and the advantage of virtually error-free records because of the elimination of manual updating.

Engineering changes

Ensuring that items are stored and issued at the correct engineering change level is a constant problem. Because of the volume of paperwork and changes, engineering changes are often not incorporated in the stores records until days or weeks after the change was originally issued. Some items, therefore, may be issued at the incorrect change level, or new parts may be binned with the same item at the old level, all of which means additional effort and paperwork in withdrawing incorrect items from the shops and reissuing the correct ones.



ITEM NO.	DESCRIPTION	SUPPLIER SOURCE	SUPPLIER NO.	SUPPLIER NAME	NEXT ORDER NO.	NEXT ORDER DUE DATE
750160	BRACKET DYNAMO MTG.	P	03274	REILLY	23771	273

STORE NO.	BIN LOCN.	DATE	RECEIPT	ISSUE	BALANCE	REF NO.	STORE KEEPER	REMARKS
01	B413 92	183	250		250	D74210	4192	
		198		110	140	S24379	4021	
		205		80	60	S13417	4192	
		213		80	0	Q 141	2231	INSPECTION
		214	75		75	Q 141	2231	RETURN
		227	200		275	D81240	4021	
		231		120	155	S30243	4132	
		241		42	113	S31423	4021	
		245			::112::		7417	STOCK CHECK
		249		40	72		4021	

Figure 7. When a query arises, all stores data for the item can be displayed

The system aids stores management by automatically maintaining the correct engineering change levels on all records and documents issued to stores. Management must still, however, ensure that:

- Stores deliveries and issues are precisely identifiable – that is, that their engineering change level is defined, along with the item number, to STORES CONTROL. On most items the receipt documentation already contains the correct engineering change number.
- Decisions are made as to whether items of differing engineering change levels may be stored together or require separate bins.
- Notifications of engineering changes obsoleting certain parts do not affect picking lists that are in the process of being filled.

Parts with the same item number but different change levels should not normally be binned together, even when the change level is physically marked on the items. For one thing, there is the risk that a storekeeper will pick the wrong item. Furthermore, stock checking becomes difficult, since the items have to be segregated by change level before counting.

Obsolete items. The system notifies stores management of any items obsoleted by an engineering change. The bins for these items can be marked "frozen" pending a decision as to the disposal of the items.

Off-standard materials

Items and material received into stores but not up to the correct quality control level should be binned separately from good parts, since their use should be restricted when allocating material against specific shop or customer orders.

The picking list will include a special indication that the material is off-standard. The shop will be notified of this, because the use of such material may temporarily affect production standards.

Receipts into Stores

As items arrive at stores, the system determines their optimum bin locations. The storekeeper is notified of these locations when the items reach him. Receipts may be:

- *Planned* – the result of earlier placement of a purchase order, shop order, rework order, and so on
- *Unplanned* – as in the case of returns to stores from the shop floor

Planned receipts

As planned receipts arrive, they should be accompanied by either of two punched identification cards:

- *A receipt identification card* for items received from outside the plant – that is, for purchased, subcontracted, or interplant items
- *A shop order identification card* for items made within the plant (for maintenance parts this will be a work order card)

The storekeeper enters the punched card into the work area terminal together with a "stores receipt" transaction code and the quantity received. He also enters his man number by means of a badge. (For details regarding terminals and badges see *Chapter 8, Plant Monitoring and Control.*)

The system checks whether the quantity entered agrees with the quantity reported as being sent to stores. If it does not, the storekeeper is notified and a request is made to repeat the transaction. If the entry still fails to agree, the storekeeper is asked to hold the receipt and a request is sent to the Inventory Administrator (Figure 8).

In the case of correct transactions the assigned bin number is displayed at the terminal. The storekeeper notes the bin number on the identification card and forwards it and the item(s) to the bin for storage. When more than one bin is required, overflow bins are also assigned (Figure 9).

Should the assigned bin already be full, the storekeeper so reports on the terminal and a reassignment is made. A message is put in the Stores Manager's Action File to investigate the reason for the error.

Counting and Weighing. The system may specify a quantity count before the receipt is stored. The procedure for this is identical to that described under "Determining Receipts to Count" in *Chapter 10, Purchasing and Receiving.*

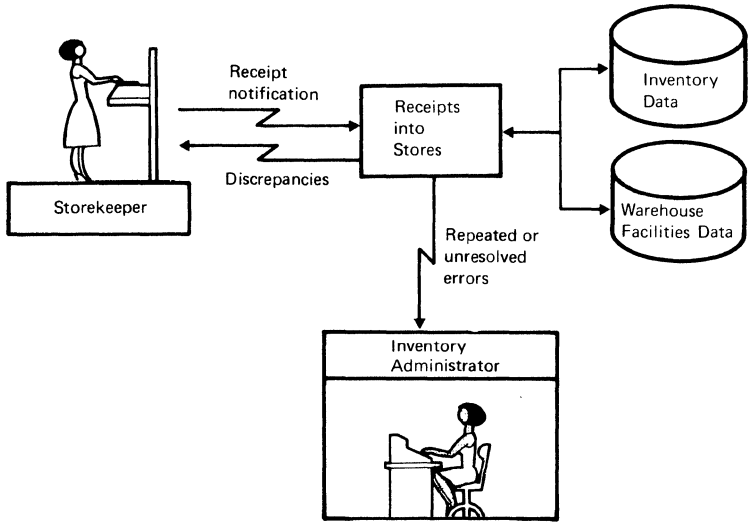


Figure 8. Receipts that do not match the reported dispatch to stores are referred to the Inventory Administrator

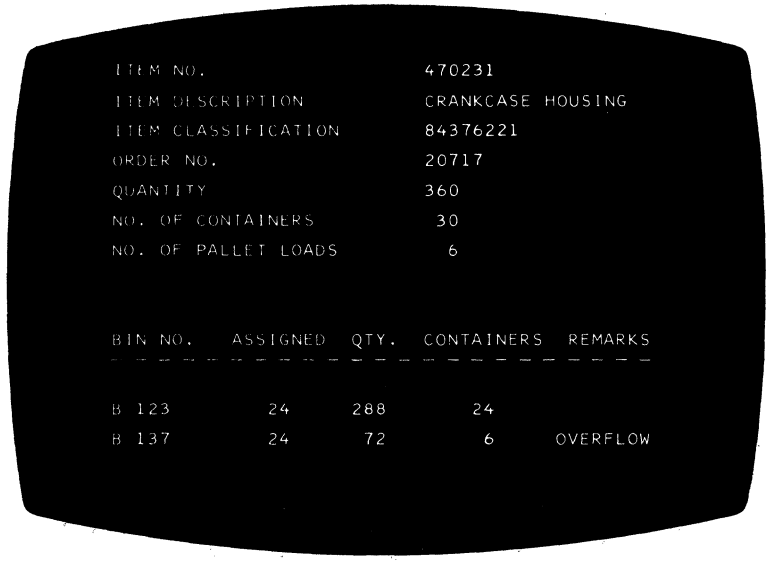


Figure 9. For correct transactions the bin assigned to the items is displayed when the receipt identification card is entered into the warehouse terminal

Unplanned receipts

Although notification of most receipts is automatically supplied by other areas, some receipts arrive at the stores unexpectedly. Examples are:

- Returns of previous issues from Inspection or Maintenance
- Returns of surplus issued items because of a lower assembly scrap rate than expected
- Receipts of salvaged items
- Returns of items not required because of an engineering change

The storekeeper uses an "unplanned receipt" code to initiate the transaction, and enters the item number, quantity and source. The system selects a bin and credits the items to stock. When surplus issued items are returned, the shop order number is also entered and the system automatically credits the return to the shop order for costing purposes.

Returns to stores should be inspected before they enter stores. This avoids the problems of wrong engineering change levels, reissue of faulty items, etc.

Returnable containers and pallets

In certain cases deliveries to customers are made on returnable containers and pallets. These should be considered normal stock items. Each container and pallet type is assigned an item number, and an item record (Figure 10) is maintained to control issues, returns from customers, and on-hand stocks.

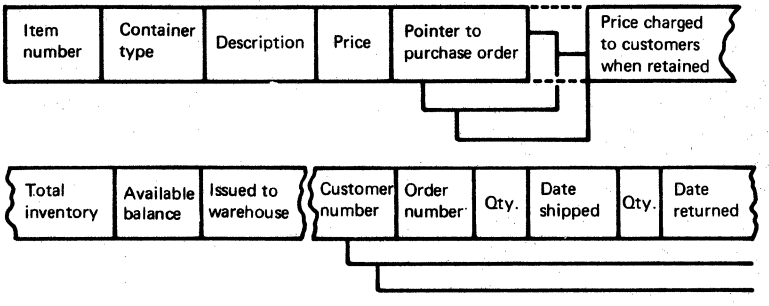


Figure 10. The item record for returnable pallets and containers provides control of total usage and of quantities held by individual customers

If a returnable container is regularly used to ship a particular end item, it can be included in the bill of material. However, if its use is unpredictable (for example, if it depends on the quantity of end items), CUSTOMER ORDER SERVICING can include the container in the order record as an additional item. When the order is reported as shipped, the number of containers used is removed from the available on-hand balance and a record is created identifying the quantity, date, customer, and order number.

Returned containers are reported by PURCHASING AND RECEIVING and are passed to STORES CONTROL, where they are handled as normal receipts. STORES CONTROL identifies the stores location to be used and, when "binning" is reported, updates the container's item record.

In the frequent cases where customers return containers and pallets in bulk quantities, the usage records are matched on an "oldest record first" basis, because of the problem of matching every shipment against individual receipts.

Order and Requisition Filling

Most of the issues made from stores are planned and generated by the system. The types of demand resulting in issues being made are shown in Figure 11. These consist primarily of:

- Customer orders for end products, spares, and service parts
- Material requisitions for shop orders – that is, requisitions either for individual items and materials or for a complete kit of parts for an assembly
- Tool requisitions for jigs, fixtures, hand tools, consumable tools, and so on
- Maintenance parts requisitions
- Requests for consigned parts to be shipped to a supplier or subcontractor

In addition, a number of unplanned issues arise because of excess scrap on assembly, test requirements, etc.

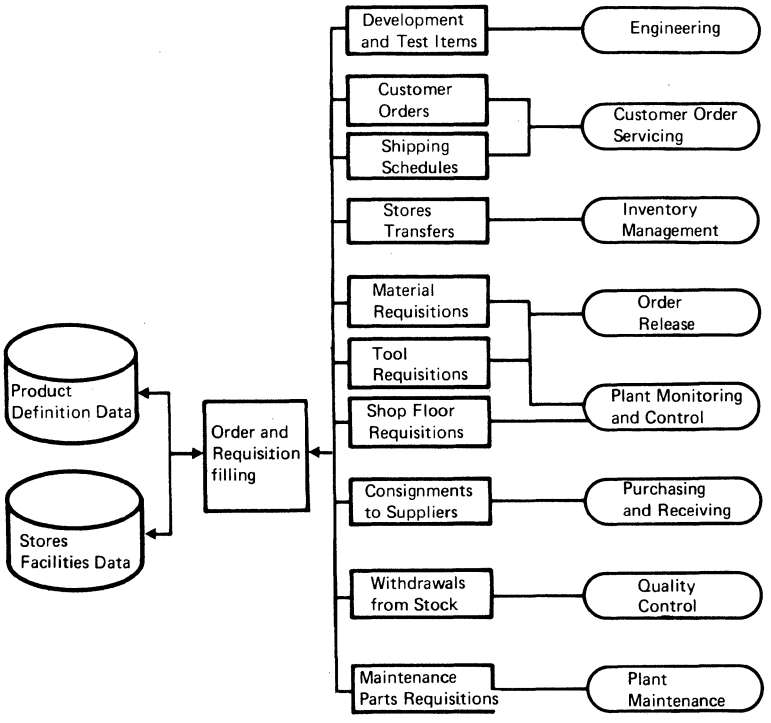


Figure 11. Demands on stores originate from many parts of the system

Work queue

All orders and requisitions are passed to STORES CONTROL via an Action File that holds the queue of jobs waiting to be issued from stores. These orders and requisitions may be filled one at a time in the case of urgent items, but normally a number of them are bulked together for picking (Figure 12). This means that stores personnel make only a minimal number of trips to the same bins throughout the day.

The system can group together a number of requisitions or orders on the basis of factors supplied by stores management, such as order priority, maximum number of picks per list, multiple orders for the same assembly components, similar bin locations, etc. Normally, however, this grouping would be done by the stores foreman (see "Work Assignment") because of the many other factors involved, such as the handling facilities needed.

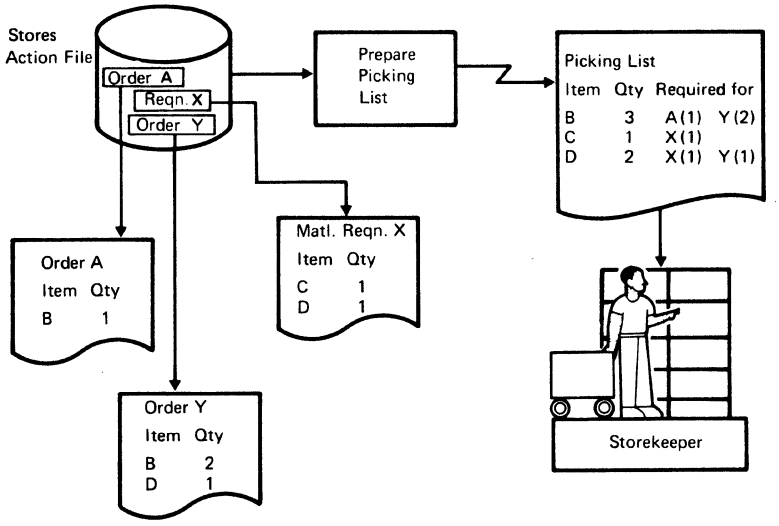


Figure 12. A picking list is made from one or several orders and requisitions waiting in the queue

Advantages obtainable from an effective order and requisition filling system are:

- Elimination of time wasted in going to empty or wrong bins
- Prevention of issuing from stock any items already allocated to other orders
- More effective use of stores labor through a reduction in the number of times a storekeeper has to go to the same bin and through production of the picking list in the physical sequence of the bin
- Reduction of throughput time – that is, the time between the issuance of a picking list and the picking and shipping of the items
- Maximum accuracy in picking
- Rapid handling of out-of-line situations, such as unexpected physical shortages

Picking Documents

The picking documents issued to the storekeeper to authorize picking can vary. The basic document is the picking list. This may be accompanied by other lists, printed instructions, or punched cards.

Picking lists

The picking list is printed on a high-speed terminal located in stores. The list is in physical bin sequence, which minimizes the storekeeper's walking distance.

Preparation of picking lists involves selection of the most suitable bin (when multiple bins have been used) for each item, based on quantity available, bin location, and rotation of stock (first-in, first-out). The items are then sequenced so that the picker takes the shortest possible route for the complete picking list. The system calculates this sequence on the basis of the location of the bins in which the required items are stored, and the dates on which the items were binned (picking speed seldom overrides stock rotation).

Items required for the same order or requisition may be printed in different picking lists (Figure 13). For instance, where storekeepers are responsible for separate sections of stores, one man may pick part of the order and another man another part. In such cases all the items for an order are gathered together at the end of picking (see "Packing").

An example of a picking list is shown in Figure 14. It contains basic information such as bin location, item number, quantity, and reference to the order or requisition calling for the items. It also considers:

- Known shortages
- Alternate items
- Stocking units

Known Shortages. Known shortages are determined at the time of order release when the inventory record shows less stock available than must be issued.

Some orders or requisitions may be released with known shortages – for instance, where the missing item can be added at a later operation, by which time inventory will have been replenished. Known shortages are printed on the picking list with a message indicating the quantity short (Figure 14).

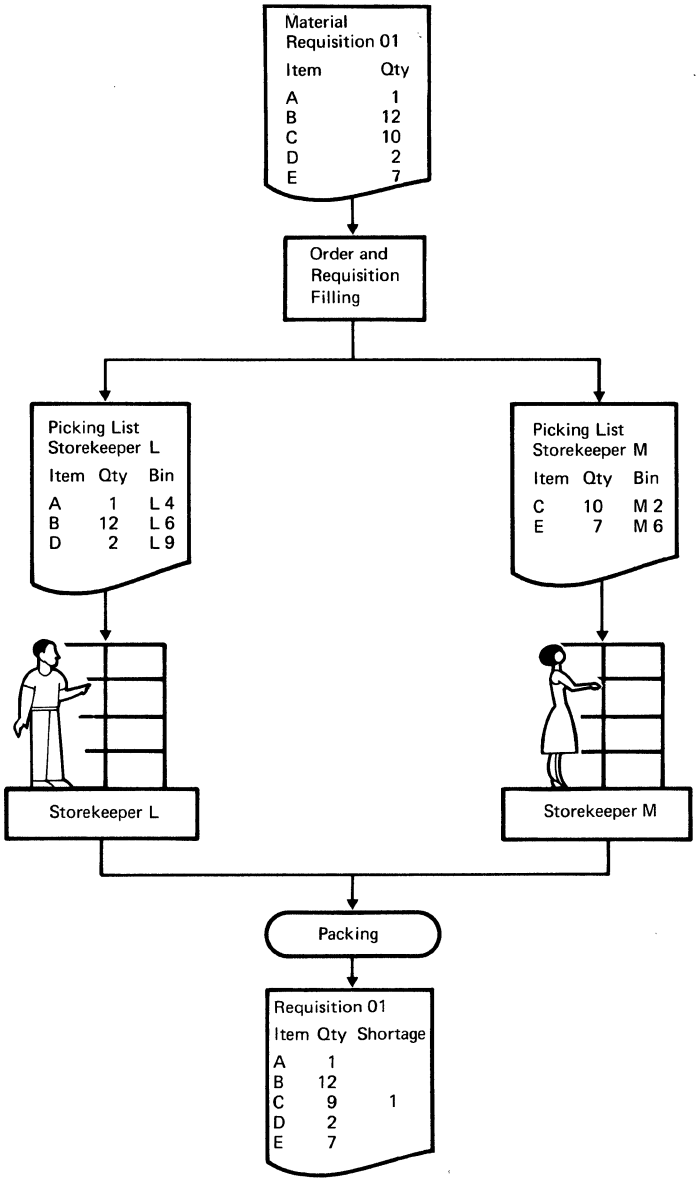
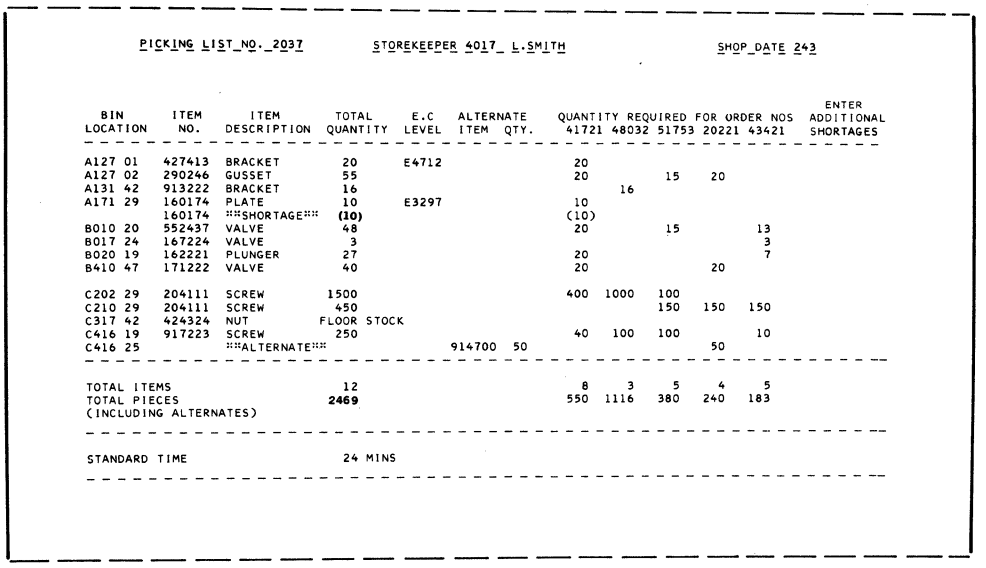


Figure 13. Where storekeepers are responsible for different sections of the warehouse, items for a given order may appear on separate picking lists



PICKING LIST NO. 2037 STOREKEEPER 4017 L.SMITH SHOP DATE 243

BIN LOCATION	ITEM NO.	ITEM DESCRIPTION	TOTAL QUANTITY	E.C LEVEL	ALTERNATE ITEM	ALTERNATE QTY.	QUANTITY REQUIRED FOR ORDER NOS 41721	48032	51753	20221	43421	ENTER ADDITIONAL SHORTAGES
A127 01	427413	BRACKET	20	E4712			20					
A127 02	290246	GUSSET	55				20		15	20		
A131 42	913222	BRACKET	16					16				
A171 29	160174	PLATE	10	E3297			10					
	160174	***SHORTAGE***	(10)				(10)					
B010 20	552437	VALVE	48				20		15		13	
B017 24	167224	VALVE	3								3	
B020 19	162221	PLUNGER	27				20				7	
B410 47	171222	VALVE	40				20			20		
C202 29	204111	SCREW	1500				400	1000	100			
C210 29	204111	SCREW	450						150	150	150	
C317 42	424324	NUT	FLOOR STOCK									
C416 19	917223	SCREW	250				40	100	100		10	
C416 25		***ALTERNATE***			914700	50				50		
TOTAL ITEMS			12				8	3	5	4	5	
TOTAL PIECES (INCLUDING ALTERNATES)			2469				550	1116	380	240	183	

STANDARD TIME 24 MINS

Figure 14. The picking list includes information on known shortages, alternates, and remaining floor stock

Later, when the storekeeper is picking the items, he may find *additional* shortages. Because of pilferage, errors, etc., the planned quantity may not be available. These additional shortages are reported when picking is completed.

Alternate Items. From the data in the product definition record, the system can recognize permitted alternates when there are known shortages. These can therefore be included on the picking list where known shortages occur. They are listed in picking sequence together with the bin number and location, and noted as alternates. When alternates are not indicated, the storekeeper is directed to pick the items listed. This reduces the problem of relying on the storekeeper's discretion in choosing alternate components or materials, and the risk of error.

Stocking Units. For some items the exact quantity requisitioned is not compatible with the stocking unit. Suppose, for instance, that a filling compound is stored in five-pound tins and a particular requisition calls for only one pound. Provided the item is not perishable, five pounds would be issued and four pounds added to "floor stock" in the requisitioning department. A record of floor stock is maintained to avoid excess issues of such items.

On the first picking list, therefore, the issue quantity would appear as "one five-pound container", and on subsequent picking lists the requirement would be shown as "floor stock" until the stock was calculated as being exhausted or returned (Figure 14). In this way the problem of excessive issues of such items as wire, paint, chemicals, etc., can be controlled.

Order identification cards

To identify each order or requisition, the system can automatically create an order identification card (Figure 15) containing such information as:

- Order or requisition number
- Customer or department number
- Destination
- Number of items on the order or requisition
- Item number (if only one item)

Order identification cards accompany the containers to their destination.

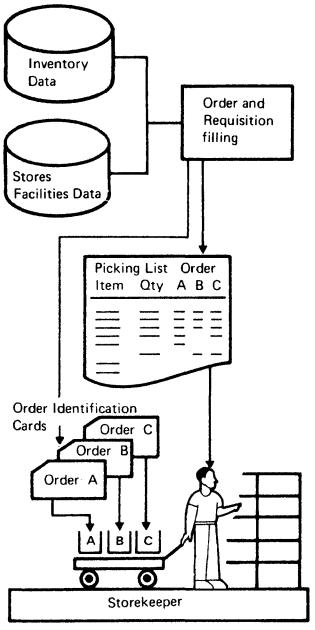


Figure 15. Cards identify individual orders or requisitions during picking

Other documentation

Other documentation that the system can create includes:

- *Special information* – for example, notification that off-standard material has been issued, special handling facilities required, etc.
- *Labels* – for packing or identification

Stores Picking Activity

Reporting of all picking activity is done via terminals situated in stores. The reporting procedure is similar to that for production activities: assignment of work, dispatching to the storekeeper, and reporting through to completion of the assignment. The overall sequence of events is illustrated in Figure 16.

Work assignment

Assignment of picking lists to individual storekeepers is done by the foreman or other qualified person. Assignment can be made at any time, but is normally done as late as possible in order to include new or rush orders in the picking list. This reduces the number of visits the storekeeper must make to the same bin; it also reduces delay in getting parts out to the shop.

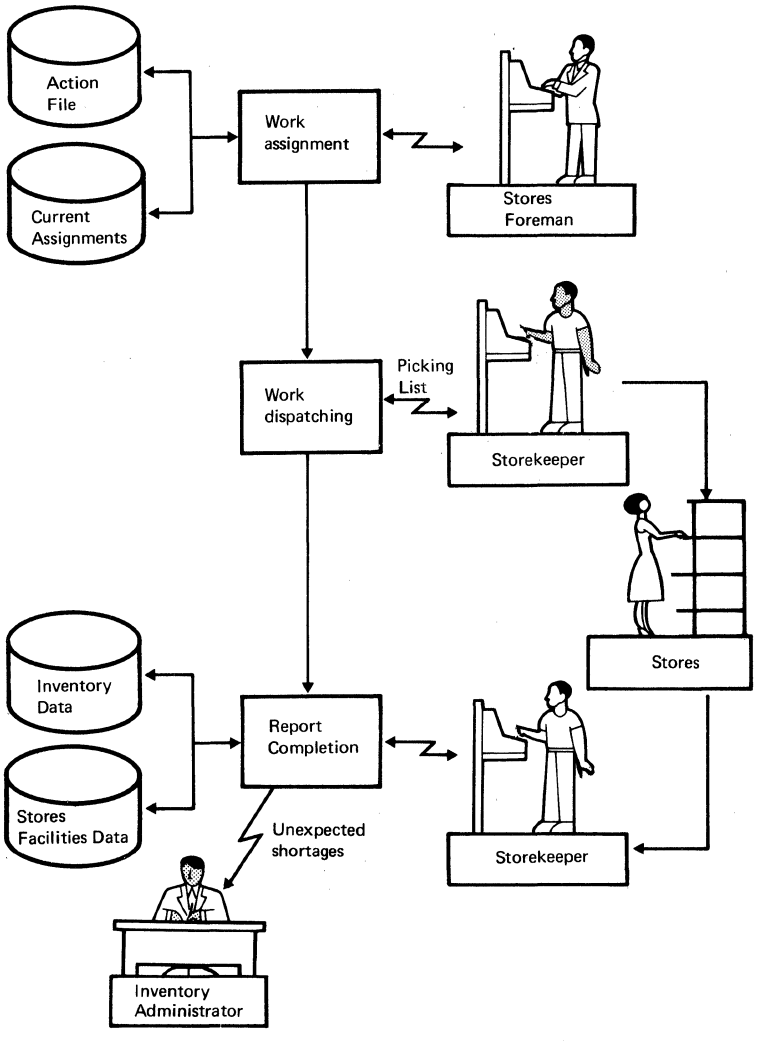
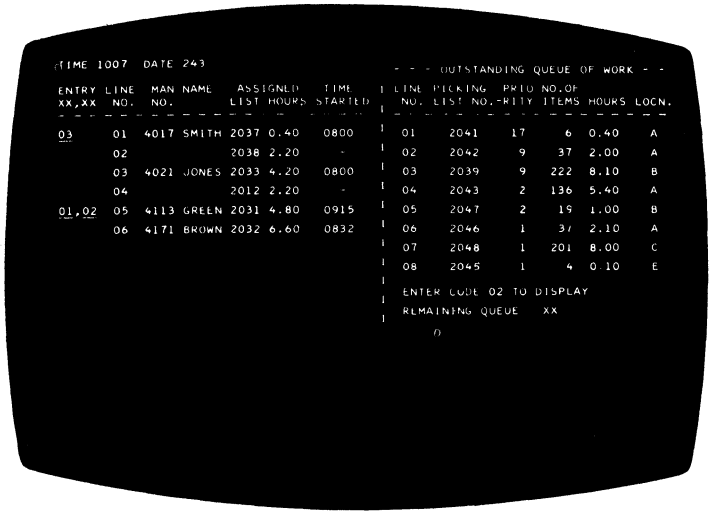


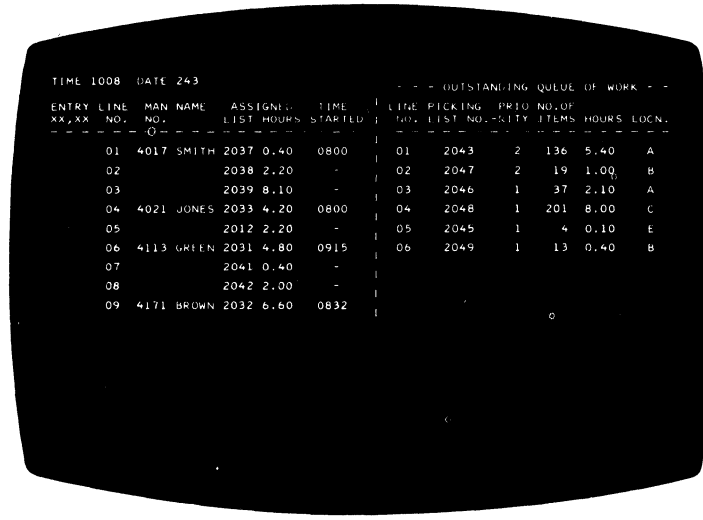
Figure 16. Functions of order and requisition filling

When the foreman makes the assignment, he requests that the unassigned jobs be displayed at a terminal (Figure 17). The sequence is determined by which individual requisitions or orders have the highest priority. The system also displays the current assignments for each storekeeper.

The foreman makes the assignment by indicating on the screen which requisitions should be pulled together to make a picking list. He then indicates a man number against each picking list. Any special instructions to the storekeeper, such as for packing or delivery, may be added through the keyboard.



The foreman requests a display of the current work assignments and the outstanding picking lists. He enters the line numbers of the picking lists against the men to whom they will be assigned (Smith and Green).



The system responds by displaying the new assignments. The assigned picking lists (2039, 2041 and 2042) are deleted from the outstanding picking lists on the right-hand side of the screen.

Figure 17. Outstanding requisitions can be displayed at the terminal together with the current assignments of each storekeeper

Work dispatching

Having picked all the items, the storekeeper reports completion through a work area terminal. His next assignment is dispatched to him automatically at that time. His next picking list is printed out at the terminal on a high-speed printer (Figure 18). This is in the picking sequence required.

Because the list is printed only as the storekeeper is ready, it is possible to include last minute changes. Such changes as an unexpected shortage on one of the items reported by another storekeeper, or cancellation of an item by an engineering change, can be incorporated.

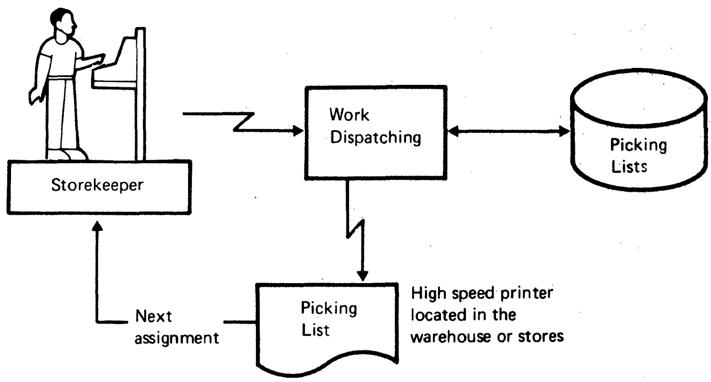
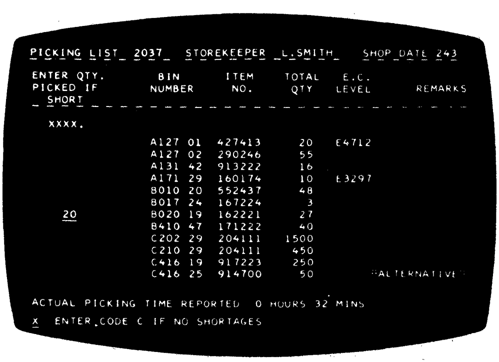


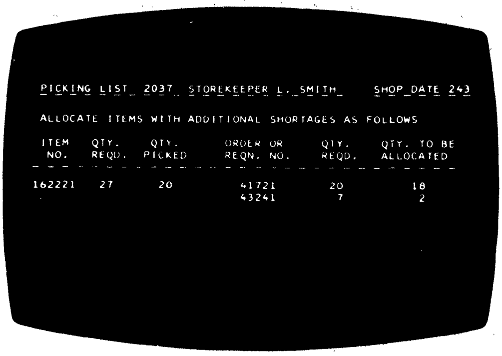
Figure 18. The next assignment is dispatched to the storekeeper on completion of his current assignment

Completion of the work assignment

When the storekeeper has completed a picking assignment, he enters the picking list number into the terminal. The list is then displayed (Figure 19). If he has picked the complete order, he enters a single character (meaning "order picked complete"). If, however, he has found additional shortages, he enters a single character identification for each item, to indicate whether it has been completely or partially picked, and for the shortage item(s) he enters the quantity picked. The system can request a physical stock count as a further check.



Storekeeper enters the picking list number into the terminal together with a completion code. The system responds by displaying the picking list. If there are no shortages he enters a code C where indicated. Where there are additional shortages, he enters the quantity picked against the item number (20 against item 162221).



The system responds by showing how the picked quantity for the items with shortages should be allocated to the orders and requisitions. The shortages can be referred to the Inventory Administrator for allocation.

Figure 19. Details of shortages are reported when picking is complete

Notification of an additional shortage automatically updates the inventory record for the item and adjusts the on-hand and allocated quantities. It also triggers a *net change* to the requirements (see *Chapter 5, Inventory Management*), which in turn may cause adjustments to planned or released orders to cover the shortage.

Monitoring of the picking task

The system continuously monitors the foreman's picking assignments. Using the manager's Action File, the system calls attention to:

- An assignment not accepted within a fixed time after completion of a man's previous assignment.
- An assignment not reported as completed when the standard time has been exceeded by, say, 20%.
- A man who has no further assignments after his current task.
- Shortages reported upon completion of picking assignment. The system provides the bin location, requisitioned quantity, and quantity picked. Other bin locations and bin quantities for the item are also listed. The foreman can request an immediate physical stock count for the item.

Unplanned Issues

Not every withdrawal from stores can be planned. Nonproduction departments will always make additional requests for production items, and the shop floor itself will generate requests because of unforeseen circumstances.

Examples of unplanned issues are:

- Replacements for parts scrapped in assembly in excess of the scrap allowance
- Issues for machine tryout purposes
- Special issues for quality control testing
- Issues to Development Engineering
- Samples with which buyers can solicit supplier quotations
- Issues to Plant Maintenance for inplant use

Any unplanned issue has to be authorized by a responsible person. Individuals may be restricted to withdrawing certain types of items. For example, Quality Control may be authorized to withdraw items whether they are allocated or not, whereas plant supervision may be able to withdraw only a limited amount of the physical stock – and even then provided it is unallocated.

Terminal entry for an unplanned issue includes:

- Part number
- Man number of requester
- Department or account charged
- Quantity

The relative priority of servicing unplanned demands and servicing planned picking schedules is determined by the stores manager. Many unplanned issues are, in fact, small and readily satisfied.

Packing

All the items for an order are gathered to confirm that, subject to known shortages, the order is complete. In the following discussion, orders (that is, customer orders), consignments to suppliers, and interplant orders are treated separately from requisitions (that is, issues made to the shop).

out-of-plant orders

Orders for items being sent outside, except for interplant orders, come from CUSTOMER ORDER SERVICING. The processing of these orders in the warehouse, however, is similar to that of shop orders.

The order identification card accompanying the items is entered into a terminal in the packing area. This causes the packaging instructions to be printed or displayed on the terminal. In addition the system produces:

- Packing material requirements
- Case lists (when required by export regulations)
- Shipping documents

This information is developed from the order and item records that become available when the order has been picked (Figure 20). After picking, STORES CONTROL informs CUSTOMER ORDER SERVICING that the order is available for packing and shipping.

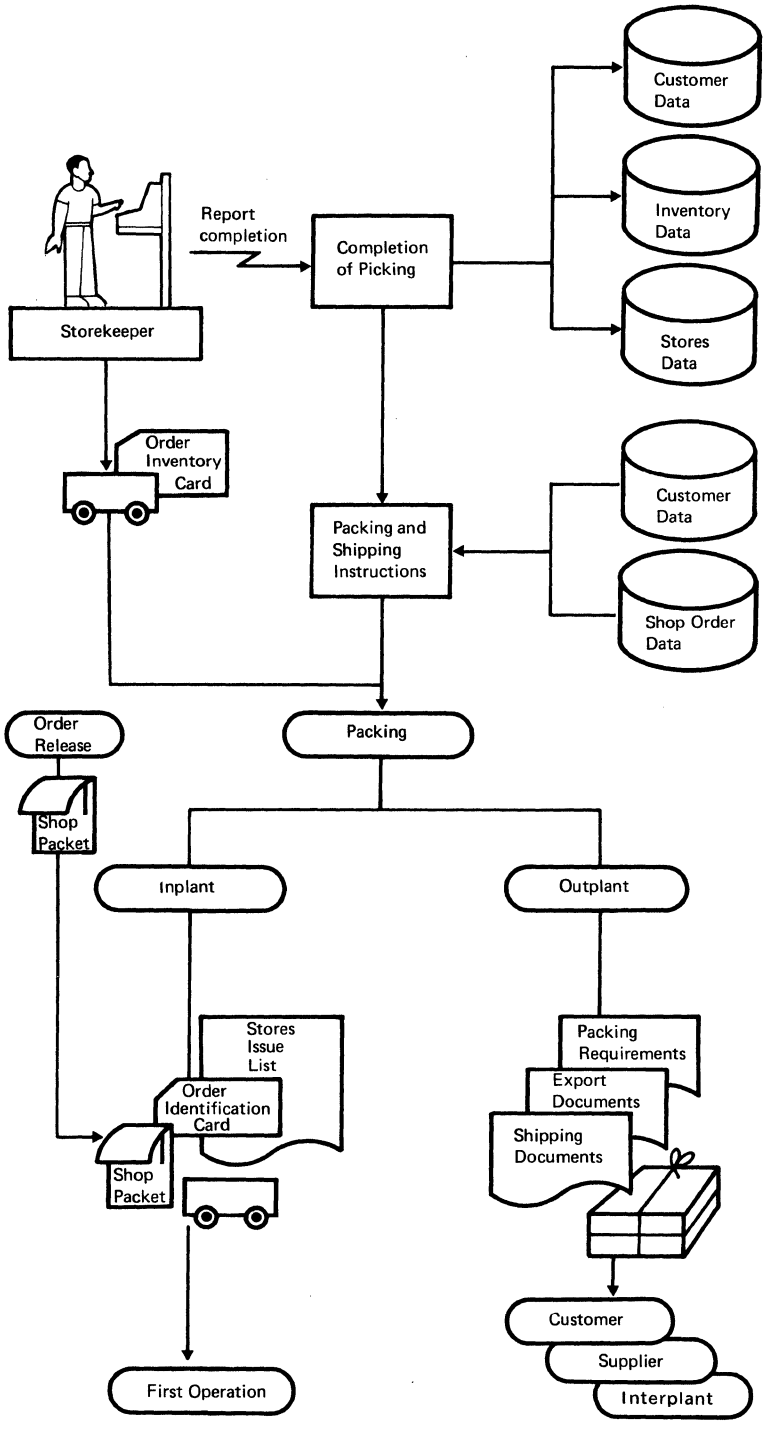


Figure 20. Packing functions

inplant requisitions

Items for issue to the shops are accompanied by:

- *Order identification card*
- *Stores issue list.* This is identical to the picking list except that it contains only items involved in this requisition. It contains the latest information at the time of picking, including shortages, alternates, and floor stock to be used. The list is requested by entering the order identification card into the terminal together with a "stores issue list" code. The list is printed out on the stores terminal. A consolidated stores issue list for a number of requisitions can be made by entering the order identification cards of all requisitions to be issued together. Special instructions can also be printed at this time.
- *Shop packet.* For the first operation on a shop order, the complete shop packet is normally sent to stores to link up with the materials or components. All documentation accompanies the items to the first operation.

Monitoring the Effectiveness of the System

STORES CONTROL and INVENTORY MANAGEMENT require information to control data and material flow within the warehouse and to monitor the effectiveness of the system. Reports can be provided in answer to terminal inquiries on all aspects of the system. These include:

- Workload in the various areas of stores, based on planned receipts and issues. Specific bottlenecks, such as a buildup of requisitions, can be pinpointed so that corrective action can be taken.
- Individual storekeeper's performance, a report made possible by the association of the storekeeper's identity with each transaction. Performance can be measured by the number of errors attributed to the man, along with his productivity (compared with management standards) in terms of, say, average number of picks per day.
- Delay reports for each section of stores, showing, for instance, how long items spend in Receiving and Packing, etc.
- Shortage control, indicating the number of additional or unexpected shortages found, listed by stores section. The audit trail capability of INVENTORY MANAGEMENT makes it possible to trace transactions on an item in order to find out where a discrepancy may have occurred.
- Stock discrepancy reports based on physical stock checking.
- Number, value and weight of incoming and outgoing shipments, by store location.

These reports and other controls mentioned earlier, such as bin utilization, can help management provide a more effective stores control system.

Basically, STORES CONTROL decides where and in what sequence to store and find items. It also monitors the execution, by warehouse personnel, of both tasks. Because the tasks themselves are carried out by people, some errors, such as the use of a different bin from that selected in advance, cannot be prevented by system monitoring. Automated warehousing methods eliminate many of these types of errors, and provide many other advantages as well.

Automated warehouses employ a wide variety of specialized handling equipment. Certain functions, however, are common to most of the automated systems:

- Storage is made up of numbers of bin locations or cells, each of which has a unique "address".
- Storing and picking are performed by devices that can be routed to an individual bin address.
- Moving items to and from these devices is performed by automatic handling systems.

These functions can be controlled by a computer, using the principles and the data described earlier in this chapter.

High bay warehousing is the method of automated storage most often encountered, and the following discussion describes automated warehouse control in terms of this type of operation. The principles involved, however, can be applied to the other forms of mechanized warehousing.

A high bay warehouse, as illustrated in Figure 21, employs cells, or pallet racks, that extend vertically beyond the range of normal handling equipment, such as fork lift trucks. Handling into and from these racks is done by remotely directed stacker cranes. Space utilization and labor costs are very substantially improved. Efficient operation depends, however, on even distribution of the workload between the stacker cranes. Items cannot be found when manual error or machine malfunction causes them to be incorrectly stored. Deficiencies normally encountered in high bay warehousing applications can be corrected by utilizing direct computer control.

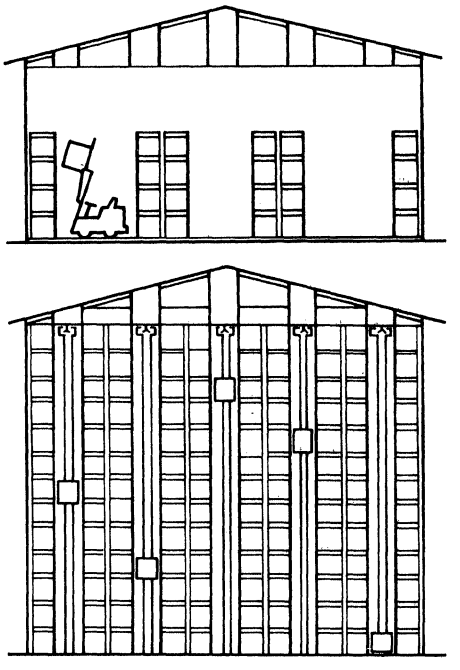


Figure 21. Comparison of traditional and high bay warehouses using the same ground area

Direct Computer Control of an Automated Warehouse

In an automated warehouse the system operates very much as in a traditional warehouse. Prioritized tasks from RECEIVING, ORDER RELEASE, CUSTOMER ORDER SERVICING, and PLANT MONITORING are assigned bins by Location Control. Storing and picking tasks are matched and placed in work queues for each stacker crane (this step replaces the foreman's job-to-man assignment). The system records the completion of each task by a stacker crane, and the crane automatically begins the next task. Items are moved to and from the appropriate cranes by automatic handling systems, which are also computer-controlled.

Direct computer control provides solutions to many of the problems of operating a high bay warehouse:

- When a man assigns an item to a storage location but either misdirects the crane or incorrectly records the location or item number, the item "disappears" into the warehouse and cannot be located without a difficult and expensive physical search. When bin selection, stacker crane direction, and inventory updating are all performed by the computer, the possibility of such error is virtually eliminated. Any mechanical failure can be detected when the stacker crane "reads" the address at which it is binning or picking items. Before binning or picking is allowed to proceed, this physical address is compared in the computer with the address to which the crane has been sent.

- Item location, both within and between aisles, can be based on volume of movement and number of issues. Items with large inventories can be located in a number of aisles in order to balance the workload on the stacker cranes and minimize the effect of a crane breakdown. Fast moving items with a large number of issues are located at the front of the aisles to reduce stacker crane travel. The result is increased stacker crane capacity and more storage and picking cycles. STORES CONTROL collects and interprets the statistics needed to determine the optimum location for each item stored.
- Real-time recording of receipts and issues means that newly emptied bins are immediately reusable. When receipts and issues are planned and processed on even a daily cycle, empty bins cannot be used until the previous day's issues have been processed. Computer control eliminates this delay and increases the warehouse capacity by up to one day's material usage.
- Stacker crane travel is minimized by combined store-and-pick journeys through the system's ability to "look ahead" and see planned movements into and out of the warehouse.

Depending on the size of the warehouse and the volume of movements, automated warehouse equipment may be controlled by a small local computer (such as in PLANT MONITORING AND CONTROL) connected to the central system and using information held in the central data base (Figure 22).

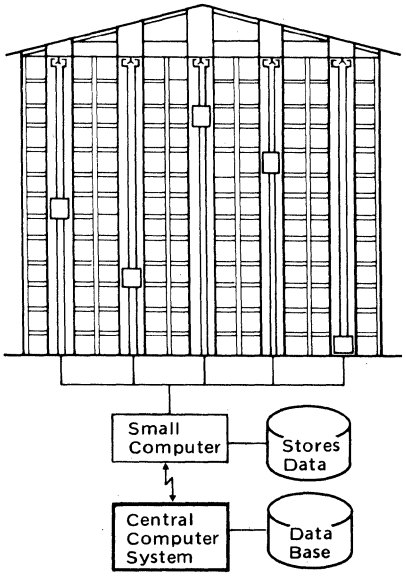


Figure 22. Warehouse equipment can be controlled by a small local computer connected to the central system

Summary

STORES CONTROL considers the physical aspects of receiving, storing, and issuing inventories planned and used by other parts of the system. In the past, many inventory control systems have failed because the physical warehousing aspects have not been adequately considered.

The term "stores" is used in its broadest sense and includes every type of inventory location within a given company. A reduction in the number of stores required can be achieved by implementing the basic disciplines together with the system described. This in turn results in better control, reduced shortages, increased accuracy, and reduced warehouse costs.

Location control achieves maximum utilization of warehouse space by not associating bins permanently with a given item number. Bin selection is done automatically by the system to optimize bin utilization and transport time. The use of terminals allows bin status and availability to be up to date at all times and eliminates the need for separate bin cards or stock record cards.

The stores foreman can assign work to the storekeeper quickly and easily by means of a terminal. Customer orders and shop requisitions are consolidated into picking lists that enable optimum use to be made of the storekeeper's time. The picking lists are generated at the last possible moment in order to reflect the latest engineering changes and inventory status.

Completion of picking is indicated easily and quickly by means of a terminal, thus increasing accuracy and minimizing paperwork. Unexpected shortages are highlighted immediately for action.

CUSTOMER ORDER SERVICING is notified of picking completion so that the necessary packing and shipping documents can be automatically prepared.

Direct computer control of an automated warehouse provides additional benefits in terms of manual movement, accuracy, time, and cost.

Chapter 12. Cost Planning and Control

Contents

Few business decisions can be made unless the factors involved are expressed in comparative financial terms. Management's requirements from a cost planning and control system, therefore, can be summarized by the questions:

- What *should* it cost to make and sell each of the company's products?
- What *does* it cost to make and sell each of the company's products?
- Where do variances occur and how can they be minimized?

Providing the answers to these questions is mainly the responsibility of the financial executive.

role of the financial executive

The financial executive has two major functions:

- Under the chief executive officer, he carries financial responsibility for the company's assets and profits. This is, in effect, a policing role, the aim of which is to answer such questions as: What did it cost to make the product? Did we make a profit? What is the value of work-in-process inventory? Was this order produced and shipped?
- As the top management team member who must evaluate management actions in terms of their effect on profits, he answers an entirely different set of questions: What will it cost? How will a particular action affect profits? Are we using resources the best way?

In the first of these roles, the financial executive is concerned with what happened in the past; in the second, he predicts what may happen in the future.

quality of data

A major difficulty frequently encountered by Finance is the poor quality of data provided by the rest of the organization: information supplied by the Production Departments is often inaccurate and too late to enable detection of problems in time for corrective action.

This does not mean that Production Departments are at fault. Often the immediate concerns of Finance differ from those of the operating departments. The financial executive is concerned, for example, with the inventory value, the cost of financing inventory, and the exposure to obsolescence, that is, with those items where there may be too much stock. Production, however, is more interested in labor and machine efficiency and material shortages, that is, those items where there is too little stock. While managing large numbers of people,

machines, items and orders, Production concentrates on completing the overdue order, keeping people and machines busy, or trying to move the work held up at a bottleneck in the plant. The timeliness and accuracy of data often assumes a secondary importance.

The financial executive is subject to pressures from many directions. He must satisfy the information needs of the tax authorities and stockholders as well as of management. The information he provides should be accurate and on time. If the basic information provided to him by other parts of the company is late and inaccurate, he cannot achieve these objectives properly, and he is often forced to choose between providing potentially inaccurate information when it is required, and providing more reliable information too late.

Cost control systems often attempt to solve the data accuracy problem by maintaining their own basic records. For example, in many companies, two separate inventory records are maintained (a formal system and an informal system). Neither, however, can be better than the transaction data feeding both of them, and it is unlikely that the systems will ever be in concert.

Advantages of COPICS design

COST PLANNING AND CONTROL obtains its basic information direct from the production control and manufacturing systems. With this COPICS concept the information, whether it relates to current or future activity, is inherently up to date and has a high degree of accuracy. Actual or planned cost information developed on this basis avoids the problems outlined above, thus helping the financial executive improve the quality of information he provides the organization.

a single set of records

From the financial executive's point of view, one of the most significant advantages of COPICS is that it is an integrated system utilizing a common set of records called a data base. This is the logic that ties all the recordkeeping functions together. From recognition of a need to make a product, through planning, manufacture, and shipment to the customer, each section of the system passes the information it develops directly to the next section. This means logical checks on accuracy can be made. Not only does Finance obtain better results, but the objectives of the production people begin to change when they use an integrated system. Instead of "fighting fires", that is, attempting to solve various problems as they arise, Production tries to operate within the constraints of a management plan in which the important policies and performance guides have been set by the complete management team.

improved planning capability

Another advantage is that many parts of the system, when properly established, relieve the financial executive of concern with day-to-day results. For example, the objectives of an inventory management system are to maintain minimum levels of inventory consistent with a chosen level of customer service. Since inventory costs rise with the level of customer service, standards for the inventory management system can be established only after a financial and marketing evaluation of different levels of customer service. Once the system is installed, it uses warning signals to alert management to any out-of-control situations, generating only exception notices of these conditions. Attention can then be directed to the next level of problems, such as predicting the cash flow needed to support planned changes in inventory level. Accurate and reliable data generated by Inventory Management provides a better basis for such a prediction (see "Projecting Inventory Investment" in *Chapter 5, Inventory Management*).

additional advantages

Other advantages are derived from a number of different sources:

- The systems approach to organizing and managing production data (the data base) allows it to be used also for managing cost and accounting data.
- The production control system develops data that can be used directly in Accounting, for example, balancing and controlling pieces produced for payroll transactions and material accountability for accounts payable.
- The system provides capabilities that specifically address the financial area, for example, a faster and more accurate distribution of overhead or burden.

Using production data in accounting

In current systems, turnaround is often so slow that control is temporarily lost while data is going through its processing cycle. For example, if several days are needed to process data on inventory issues, the system's inventory records are rarely in line with physical inventory, and reconciliation of the two sets of figures is very difficult. In a real-time system approach, such as COPICS, the use of production data by Accounting means that the data is transferred without the need for intermediate printing, copying, punching, or verifying. Consequently, the errors and delays normally caused by these activities are significantly reduced.

The advantages of a costing system based on production data are:

- Data has an improved level of accuracy
- New types of measurements for management are available
- New techniques, such as cost simulations, can be applied to production data
- Data duplication is eliminated

data has an improved level of accuracy

Real-time systems allow extensive editing and checking of data as soon as it is entered from terminals throughout the plant. When errors are detected they are reported immediately to the employee entering the transaction, or to the appropriate managers, and therefore can be resolved before the events have been forgotten.

Even where the data is stored for subsequent processing in a batch environment, immediate editing of data, possible only with a real-time system, creates substantial improvements. The correction of errors as they happen reduces the amount of data rejected during the batch processing. Consequently the amount of computer time wasted because of the rerunning of batch systems is dramatically reduced. Rejected data that must wait for the next regular batch run reduces the value of the system. Records of inventory will not be used if a large percentage of last week's issues have remained unprocessed as a result of rejection. Likewise, job status records will not be trusted if discrepancies in labor reporting have not been corrected in time to run the reports.

In a real-time system, both the operating departments and the financial departments benefit from fast, accurate reporting. For example, a cost change arising from a raw material price increase can be reflected in the standard as soon as desired. The ability to rapidly update standards and budgets means that a firmer commitment can be obtained from cost center managers, because measurement standards are more reliable.

new types of measurements for management

The system described in this manual uses statistical techniques in a large number of areas. For example, statistical frequency distributions are established in many situations that currently are often uncontrolled. The ability to measure cost variations statistically leads to better control. For example:

- Measuring the variations in demand for stocked items enables inventory levels to be reduced to a point consistent with a specified customer service level.

- Measuring variations in the length of work queues at each production machine enables these queues to be controlled and reduced, minimizing work-in-process.

new techniques can be applied to production data

Many of the planning systems work as if they were simulators. For example, in order to smooth the load at a work center, ORDER RELEASE PLANNING "simulates" the effect of moving orders from one period to another until a satisfactory solution is reached. If management decides to change the available capacity, the system evaluates the effect of different capacities and helps in the selection of the most economical level.

The same system can also simulate the effect of alternative management actions. Basic information, such as capacities, queue lengths, and operation standard times, can be changed and the effect analyzed. Also, the effect of increased or decreased sales, shop orders, or purchase orders can be simulated. The detailed results are compared with current conditions and the effects on such factors as manufacturing lead time and work-in-process inventory level can be evaluated.

data duplication is eliminated

The function of the data base is to integrate manufacturing and financial data. The principal objectives of the system's data management functions are:

- To remove the need for multiple copies of data
- To make the data available to every authorized user in the form in which he needs it
- To connect related data items and thus speed information retrieval

Figure 1 illustrates part of the manufacturing data base and shows the relationship between cost-oriented information contained in separate areas of the data base. Information organized in this way enables a single transaction to trigger a series of record updates. From the financial executive's point of view, avoidance of delays between successive updates of different records removes the cause of many reconciliation difficulties.

While much of the source cost data is embedded in the manufacturing data base, information specific to accounting can be stored and summarized in a separate financial data base, using the same type of data organization. For example, the different levels of departmental expense budgets can be organized like the bills of material used in the product definition data base. The techniques used for exploding and summarizing component requirements can then be used to summarize and build up elements of cost.

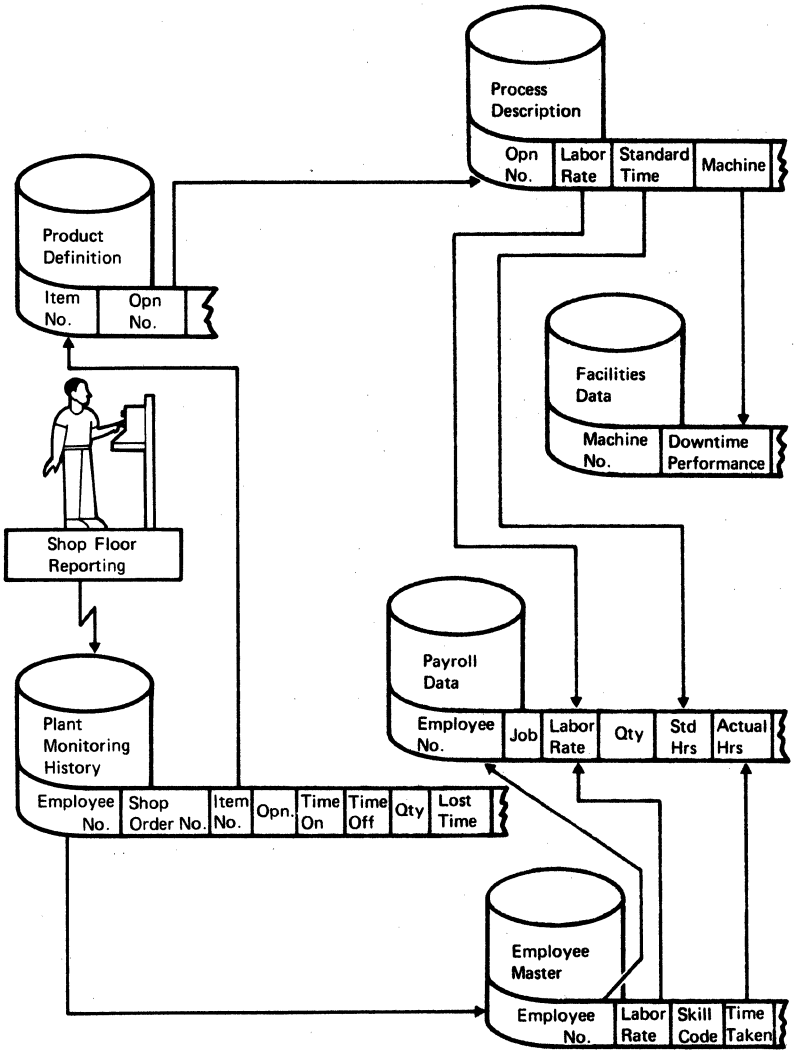


Figure 1. When PLANT MONITORING AND CONTROL provides completed operation transactions, information required by Finance can be immediately available

Audit and control

In existing systems many auditing and control problems arise from the batch processing methods employed. Control over totals and numbers of transactions processed is necessary because of the many times each batch of documents is handled between initial creation and receipt of the final results.

Also, batch processing leads to many rejected records at the time of editing, with subsequent rerunning of this rejected data. This in turn creates reconciliation problems between processing runs. Tracking the processing of an individual series of transactions in these circumstances can be difficult and expensive.

In a real-time system, many of these problems are eliminated. Real-time reporting of individual transactions, with simultaneous updating of all affected records, removes the need for controlling batch quantities. Inline editing of these transactions results in the correction of most errors at source, so that transactions are processed without delay.

A comprehensive audit trail capability in this environment can be built on the basis of periodic "snapshots" of the data base together with a log of the transactions received for processing. In a real-time system this information is recorded for purposes of system security and to provide for complete recovery of the system's records in the event of a malfunction in the computer system. These facilities are provided and managed automatically by the system, and when the data is no longer required for system purposes it can be retained on a low-cost storage medium to satisfy auditing requirements.

The need for integrity of system records is discussed in *System Requirements.* This section also underlines the value of having auditors with data processing knowledge participate, from the earliest stages, in the design of the system.

Functions of Cost Planning and Control

The facilities that become available to the financial executive when the system is installed are discussed in this chapter principally under traditional cost topics, such as:

- Direct Labor and Material – planning direct labor and material costs, and controlling variances
- Other Direct Costs – incorporating some variable overhead costs in direct costs
- Overhead Costs – distributing overhead costs to departments and products – planning and controlling departmental budgets

The final portion of the chapter discusses the areas of long-range planning, capital expenditure, and work-in-process investment.

Relationship with other application areas

COST PLANNING AND CONTROL is, of course, related to all the activities in a company. Other COPICS areas that provide information for specific functions of COST PLANNING AND CONTROL are illustrated in Figure 2.

Simplified implementation

It is not necessary for installation of the costing system to take place at one time. As each manufacturing system is installed, the associated section of the costing system can be modified or developed to use the newly available data. For example, establishment of the product definition and process data base provides a basis for establishing and controlling direct labor and material costs. Engineering Change Control enables these costs to be updated automatically. INVENTORY MANAGEMENT and PURCHASING AND RECEIVING permit basic inventory accounting. Work-in-process inventory accounting can be implemented when PLANT MONITORING AND CONTROL is installed.

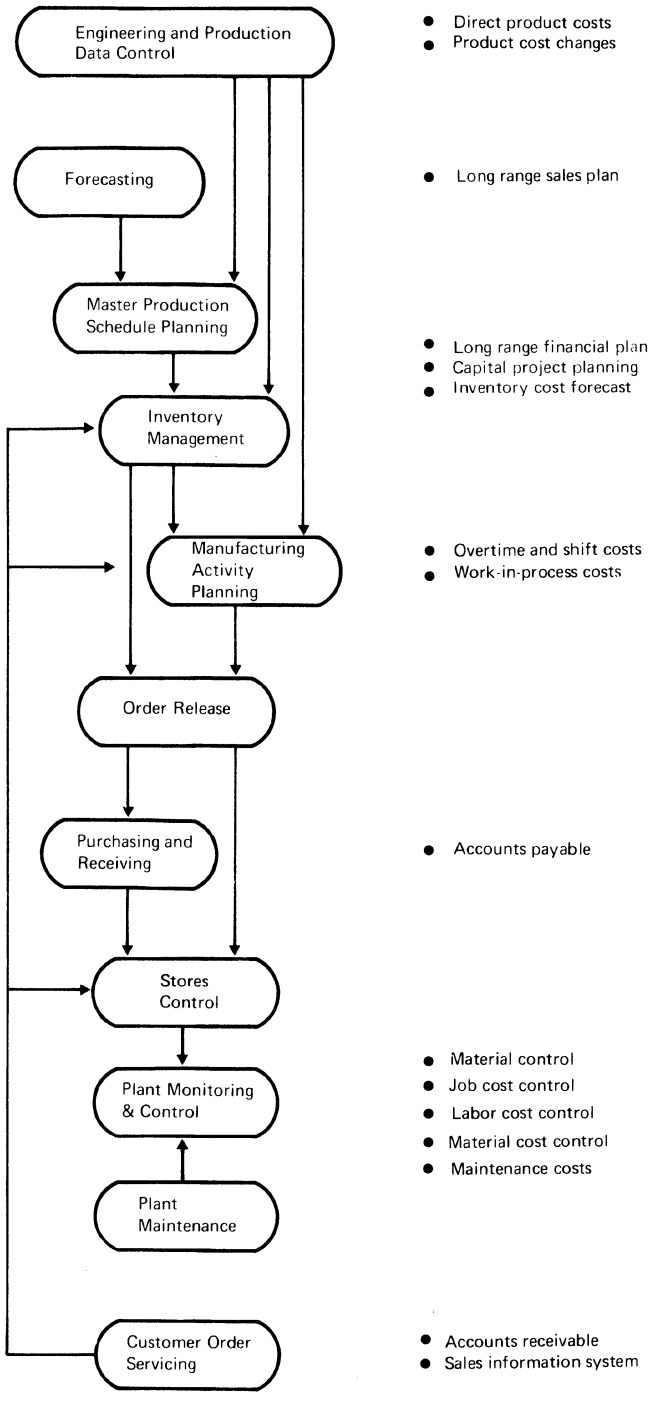


Figure 2. The relationship of other application areas to COST PLANNING AND CONTROL

The information needed to plan and control direct labor costs is supplied by:

- ENGINEERING AND PRODUCTION DATA CONTROL, which provides bills of material and routings with labor standards
- MASTER PRODUCTION SCHEDULE PLANNING, which provides end item requirements used for planning purposes
- MANUFACTURING ACTIVITY PLANNING, which provides detailed labor requirements for the immediate future
- PLANT MONITORING AND CONTROL, which provides detailed production and labor information relating to actual production

Direct Labor Cost Planning

The planned direct labor cost for an item may be a cost estimate or may be derived from direct labor standards. If direct labor standard times are used, the standard direct labor cost is calculated from the labor standard and the average hourly rate paid for the operation. It is stored in the item record in the product definition data base.

Bill of material costing

The file organization techniques used in COPICS enable every usage of each item to be found. Consequently, in a single computer run, the standard direct labor cost can be accumulated for a part and then extracted from the item record and accumulated into the direct item cost of every assembly in which the item is used. When this process is applied to the entire product definition data base, starting at the raw material level, through operations, to the component level and working upward one level at a time, to the finished product level, an accurate standard direct labor cost is obtained for each end item.

This procedure is used as required to update the costs in the data base. Low-level codes are used in the process of building up this cost, so that item records are processed at the right point (see *Chapter 1, Engineering and Production Data Control*). Any change to the product definition data can be immediately reflected in the standard cost of every assembly and end item affected. Therefore, labor cost standards, which are often not revised because of the massive volume of clerical work involved in maintenance, are fully current. An across-the-board change to hourly labor rates is quickly reflected up through the components and assemblies to finished goods.

Using standard direct labor costs

The standard direct labor cost represents an ideal cost. It can include allowances for the effect on normal operation time of such factors as variations in raw materials, or operator fatigue. However, to use these standards as the sole basis for planning would be to assume that performance always equals standard.

In practice, experienced operators, on the one hand, often perform better than the standard, and on the other hand, machine breakdowns or material shortages arise to interrupt production. Identifying and measuring these variances is discussed later in "Direct Labor Cost Control". Planning for these variances can be based on an average of past levels of these cost elements, modified by management's estimate of the extent to which improvement is possible. The variances, stated as a percentage of the direct labor cost, are included as expense items in departmental budgets for each period, and control is exercised against these expense budget amounts.

As manufacturing methods and costs change, the standards for direct labor cost must be brought up to date. How often this should be done depends on how much direct labor cost analysis is performed.

In many present systems, standard costs are often revised at regular intervals, say yearly, when the profit forecast is being made. Therefore, a fixed standard exists for the period between alterations. Cost changes occurring between regular reviews therefore show up as variances, which are often charged to departments not responsible. For example, when an engineering change increases the labor standard for an operation, the actual direct labor cost is derived from a new labor standard, but if this is compared with the old standard labor cost, the difference may appear as an efficiency variance against Production.

This problem can be solved by creating a new standard whenever a permanent cost change is recognized – as when a material price increases or a manufacturing method is changed. This, however, may result in a large number of standards, each different from the one used as a basis for forecasting profit.

The standard direct labor cost in the item data base record is the one that was used for the profit forecast. Attached to the record of this cost are a series of cost change records. Each one contains the *net change* to the standard, the date from which it is effective, and a code indicating the reason for the change. Each time this record is obtained, the appropriate standard is used. In Figure 3, for example, the standard labor cost of 16.42 was used for profit planning for the current quarter.

It has since been changed twice. In period 4 it was increased by 2.18 to 18.60 as the result of a reduction in lot size when production was moved from an automatic screw machine to a turret lathe. In period 5 the standard was reduced by 1.06 to 17.54 by a methods improvement.

In period 7 a quantity of 520 of this item is completed at a direct cost of 9,200.00. What is the variance? The shop foreman's direct labor should show an unfavorable efficiency variance of 79.20 obtained by comparing the actual cost with the *current standard*, which is the one against which he should be measured. Compared with the profit forecast, however, there has been a total unfavorable variance of 661.60, obtained by comparing the actual cost with the original standard. What happened to the difference of 582.40 which must be written off against profits? It is, of course, made up of a favorable variance of 551.20 due to a methods improvement, and an unfavorable variance of 1,133.60 due to the reduction in lot size.

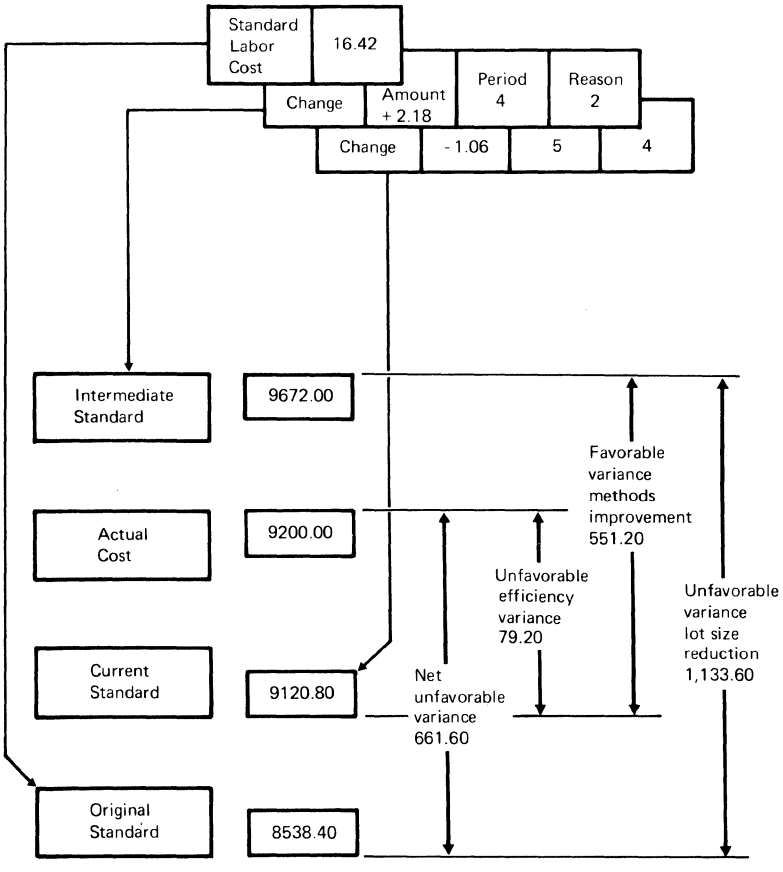


Figure 3. Changes to standard costs are stored and used for detailed analysis of cost variances

Is it necessary to analyze variances to this extent? The answer will differ with the magnitude of the variances and the degree of management control desired. This system for storing changes to standards provides the following advantages:

- The total effect of variances on planned profits is provided.
- That part of the total that is attributable to individual managers can be accurately determined, and their performance can be monitored fairly.

Direct Labor Cost Control

The basic information from which *actual direct labor costs* are determined is provided by PLANT MONITORING AND CONTROL, which provides data on each operation on the shop floor. It includes the following items:

- Shop order number
- Operator identification
- Machine or work center identification
- Start time and date
- Finish time and date
- Quantity produced

The times at which production starts and stops for machine maintenance and other reasons are also reported, along with a code specifying the cause of any interruption.

This information, which is required for reporting job progress, is also used in the payroll system and for accumulating direct costs on a departmental and a product basis. Extending the elapsed time by the labor rate for the operation yields the actual direct labor cost of produced items. Another approach is to extend pieces produced by standard, to obtain earned hours, and then multiply earned hours by the man's hourly rate. The work-in-process value of the order can then be updated. The payroll system calculates the value of each element of cost, and passes the detailed information to Cost Planning and Control.

Variance control

By comparing the actual cost of the operation with the appropriate standard, the system obtains the cost variance. Among the reasons for variances are:

- Volume change
- Machine malfunction

- Tool maintenance
- Material shortage
- Product engineering change
- Process change
- Faulty material
- Alternative material
- Labor hourly rate change
- Efficiency variation

When these cost variances are analyzed, the elements for which the cost center manager is responsible must be separated from those over which he has no control.

The extent to which direct labor cost variances can be analyzed is almost unlimited. When determining the required degree of detail and accuracy, the following factors should be considered:

- Is the amount of the variance large enough to justify further analysis?
- If standards and budgets are varied to provide better comparative information, will the original figures, on which the profit forecast is based, become meaningless?

Figure 4 shows how these factors are interrelated.

The question is: Has the work center manager done a good job, or are his costs excessive? It is impossible to answer this question from the costs shown in Figure 4. The difference between planned and actual production quantities hides the true variance in labor cost.

If the planning figures are increased proportionally to allow for the volume variance, the result is as shown in Figure 5. It now seems that the work center performance was below standard. But which standards were used to develop the planned direct cost? The lowest cost standards, or the rate used for payment, which would have allowed for alternative methods and materials?

	Production Units	Direct Labor Cost	Lost Time
PLAN	10,000	2,200.00	126.00
ACTUAL	11,500	2,700.00	140.00

Figure 4. Labor cost comparisons based on different production levels will not be accepted by production management

Detailed analysis, with dynamic budgets, provides the maximum control over cost center managers. Separation of individual variances can be on the basis discussed in "Direct Labor Cost Planning". On the other hand, if the total cost of a specific direct labor variance is small, there may be no need for detailed analysis. The decision can be determined solely by the requirements of the system, since the computer can handle the most detailed analysis without difficulty.

	Production Units	Direct Labor Cost	Lost Time
PLAN	11,500	2,530.00	145.00
ACTUAL	11,500	2,700.00	140.00
VARIANCE		+ 170.00	- 5.00

Figure 5. Control is improved when the comparison of costs is brought to a common basis

variances not controlled by the cost center manager

Changes in product volume and mix cause variations between the planned and actual total direct labor cost; a practical method for controlling these variances has been the use of flexible budgets. When companies find that the product quantities they make and sell rarely coincide exactly with their sales forecast, they are often not prepared to recalculate the entire budget after the production volume is known. An alternative solution has been to create departmental budgets for a range of volumes, and to use the closest budget to the actual production volume as a basis for comparison. Although this method is inexact, it provides a more accurate basis for comparison than a budget that has been rendered completely out of date by an unexpected increase in production.

However, the effects of volume and product mix variation can be eliminated completely if direct costs are recalculated for the level of production actually achieved. For direct labor costs, this involves calculating the standard cost of actual production and comparing it with the actual cost of actual production. The speed of the computer-based system, together with the standard data available in the data base, makes this recalculation economically feasible. It is performed when the actual cost is calculated in the payroll system.

Product, process, and material changes are usually outside the control of shop foremen. For example, when an alternative operation is scheduled by MANUFACTURING ACTIVITY PLANNING, the shop order record contains the details of the selected alternative. Consequently, the comparison of actual and standard costs is made on an equitable basis.

However, since any increase over the standard has an impact on profit, the variance must be reported against the appropriate cost center. In the product and process definition data bases, standard and alternative manufacturing methods are separately identified. Variances are first calculated by comparison with the standard that was used, and then by comparison with the basic standard. When the standard method or material is scheduled, any variance due to the use of alternatives is shown as the responsibility of shop management; when the alternative is scheduled, however, the variance due to the alternative is isolated and shown against the production scheduling system.

variances controlled by the cost center manager

Lost production time arises from such causes as machine breakdown, tool maintenance, or material shortage. Such waiting time during production is recorded, with the appropriate reason code, by PLANT MONITORING AND CONTROL. The cost is calculated, extracted, and accumulated by reason code in the departmental expense analysis. Since some cost variance due to these causes is inevitable, a planned amount is included in each cost center manager's budget to cover the amount normally experienced. The actual variance is measured against this budget amount. To improve control over the expense planned, further information can be made available to management. For example, machine maintenance time, along with the time lost while waiting for machine maintenance, is collected for each maintenance craft. It can also be summarized by department or product, to highlight areas where maintenance performance is above or below target.

Budgets for these factors can be adjusted dynamically by the system. For example, if a volume variance results in a substantial increase in direct labor hours worked, the budget for lost time becomes inadequate. When the volume variance is recognized, the system automatically recalculates the budget for lost time.

Labor rate and efficiency variances arise from nonstandard hourly rates and from fluctuations in departmental efficiency, as Figure 6 shows. These are isolated on the operating expense statement of the department concerned, since they are usually within the control of the foreman.

Instead of 10 Hours at 5.00 costing			50.00
Actual is 9 Hours at 4.00 costing			36.00
Variance		Favorable	14.00

Variance - Rate

10 standard hours at	(5.00 - 4.00)	Favorable	10.00

Variance - Efficiency

10 - 9 hours variance at	4.00	Favorable	4.00

Variance - Total

		Favorable	14.00

Figure 6. The effect of nonstandard hourly rates must be identified if efficiency variances are to be calculated accurately

The requirements of a materials costing system vary widely with the nature of the manufacturing process, the nature of the materials used, and the significance of total material cost in relation to total product cost.

Figure 7 illustrates a system of standard material costs, applied through a conventional job costing system. Although the costing calculations vary if other product costing systems are used, the basic information that is recorded and stored is generated in a similar manner.

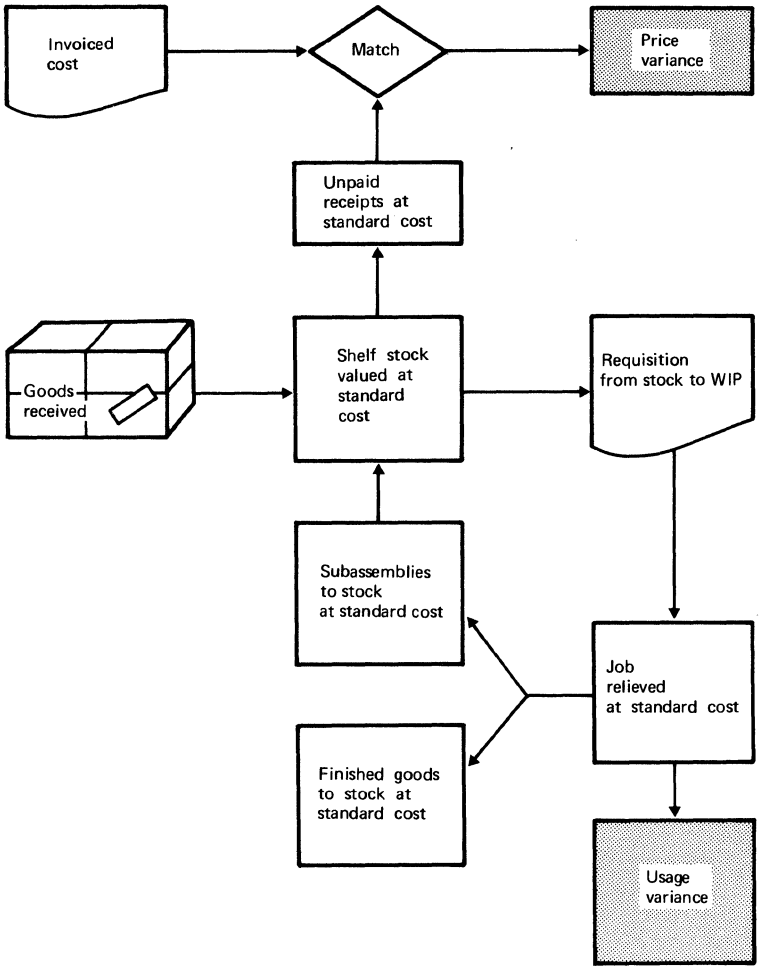


Figure 7. Material control in a standard costing system identifies cost and usage variations separately

The accounting system illustrated holds stocks of materials and components at standard cost. Differences between standard and invoice price are then isolated as price variances. Materials issued from stock are included in work-in-process value and ultimately charged to finished products at standard cost, so that variances isolated during production are usage variances. In this way the total cost of materials is accounted for either as a part of the product cost, or as a variance in an expense budget.

Direct Material Cost Planning

The planning of direct materials usage is fundamentally similar to that for direct labor. During creation of the routing describing the manufacturing process for each item, the production engineer estimates the material usage for the item. Included in this usage is unavoidable material wastage, such as the loss on steel bars resulting from cutting and from bar ends, or the material remaining when a part is blanked.

In addition to this material wastage, the production engineer establishes a standard allowance on each part for scrapped material, which depends on the nature of the process and the established scrap rates for the work centers. This standard scrap allowance is expressed as a percentage applied to planned requirements. The standard material usage and scrap allowance are stored in the item record in the product definition data base.

The standard direct material cost is calculated from the standard usage and the standard raw material unit price. The standard material price is also stored in the item record.

Material pricing

Standard purchase prices for materials and components are reviewed regularly by Purchasing, and variations due to volume changes, or alterations to supplier costs, are reflected by appropriate updating of the product definition data base. When controlling variances in material costs, it is important to distinguish between price changes that were included in budgets and are consequently reflected in planned profits, and those resulting from specific orders and having an impact on planned profit. Anticipated material price changes are recorded in the same way as predicated changes to direct labor standards. The change to the standard price, the period in which it becomes effective, and the reason for the change, are added to the standard price record.

This method of recording enables a detailed analysis of variances to be carried out.

types of costing methods

When job costing is used, the material cost for an item may be estimated in a single step. Since there is no standard material price, some form of actual cost is used. The costing method will depend on the type of product, the significance of material cost as a part of total product cost, and the stability of material costs.

Average material cost is similar to the use of standard material costs. The average cost is stored in the item record for the material, and variances are identified when materials are invoiced.

Weighted average material cost requires the calculation of a new average price when each material receipt is invoiced. The system multiplies the current weighted average cost by the old quantity in stock, adds the invoiced cost of the new delivery, and divides this total value by the new stock quantity to give the new weighted average cost. A current weighted average material cost is maintained automatically by the system, and materials issued to jobs are issued at that cost per unit.

First in, first out method of material pricing provides the most accurate means for evaluating inventory. Each consignment of material is stored separately, and materials are issued to jobs in the same sequence as received. For each consignment the system maintains a record that holds the quantity, the date on which it was received, and the price. As material is issued to jobs, the oldest material is used, and the appropriate price is charged to the job. This method, which increases the cost of recordkeeping in a manual system, presents few problems when the system maintains the records automatically in conjunction with FIFO storage methods.

Bill of material costing

The discussion of direct labor costs described a technique by which the standard cost of an item is accumulated into every assembly on which it is used, up to the end product level. This technique is used also for standard material costs. The standard item cost so developed now contains both direct labor and material cost elements.

The direct cost information held in the product definition data base enables costed bills of material to be produced whenever required. This provides the following advantages:

- A costed bill of material (Figure 8) can be produced on the basis of current costs or forecast changes to standard costs through some future date. The combined effect that all foreseen cost changes will have on the end item cost can easily be calculated.

Bill of Material Accounting							Month	Year		B.M. Number			Sheet Number
							6	1		137806			1
Item Number	Qty	Date	Total Price		Purchased		Manufactured						Subassemblies	
							Material		Labor		Overhead		Labor	Overhead
194969	4		33	055			20	033	6	991	6	031		
137944	1		20	125	20	125								
137999	1		45	200	45	200								
Percent change 9.1 CR	New	Material	98	380	65	325	20	033	6	991	6	031		
		Total	98	380										
	Old	Material	108	200	108	200								
		Total	108	200										
	Diff	Material	9	820-	42	875-	20	033	6	991	6	031		
		Total	9	820-										

Figure 8. On the costed bill of material, old and new standard material costs and the percentage change can be shown

- Alternative material costs can be temporarily inserted in the product definition, and the resulting change to the end item direct cost can be determined.
- Simulation can also be carried out when a proposed change affects an item (or a class of items) with multiple usages. The *where-used* capability of the system (see *Chapter 1, Engineering and Production Data Control*) enables every affected end item to be identified quickly, and the cost change to be calculated.

value added tax

Where *value added tax* is used, it is necessary for the cost of purchased materials, components, and services, within an end item cost, to be separated from the total value. This allows the value added during manufacture to be calculated. This can be accomplished by identifying separately the purchased element in the cost of each component record; this is either the component purchase price or the material value of a manufactured item. Separate cost fields are provided

in all assembly and end item records for both the labor content and the material content of components incorporated in the assembly. As costs are summarized upward to the end item level, the total cost of purchased materials is maintained, and the difference between total end item cost and end item purchased material cost provides the added value.

Direct Material Cost Control

Price variances

In a standard costing system, the control of direct material costs differs from that of direct labor costs in that price variances are isolated from the actual material price before the material is taken into stock, whereas usage or quantity variances are calculated when production is complete. Materials in inventory can therefore be held at a single standard cost.

Purchasing and Receiving creates and maintains a record of all orders placed with suppliers. The information contained in this record includes not only purchase order details but details concerning receipts and inspection. This information is used by Accounts Payable and can help avoid many problems resulting from matching suppliers' invoices.

When suppliers' invoices are received, details of the invoices are entered at a terminal. The system finds and displays on a screen the order details, as well as details of any deliveries received against the order which are currently unmatched by suppliers' invoices.

The clerk identifies the record of the matching receipt. If the receipt passed inspection, the quantity accepted is displayed together with the disposition of any rejected items. Figure 9 shows the displayed information.

The invoice is visually verified against the order and delivery information, and if the verification is satisfactory the invoice is accepted for payment. The invoiced amount is simultaneously distributed to the appropriate material account, the unmatched receipt record is removed from the file, and the purchase order record is updated to record the quantity passed for payment.

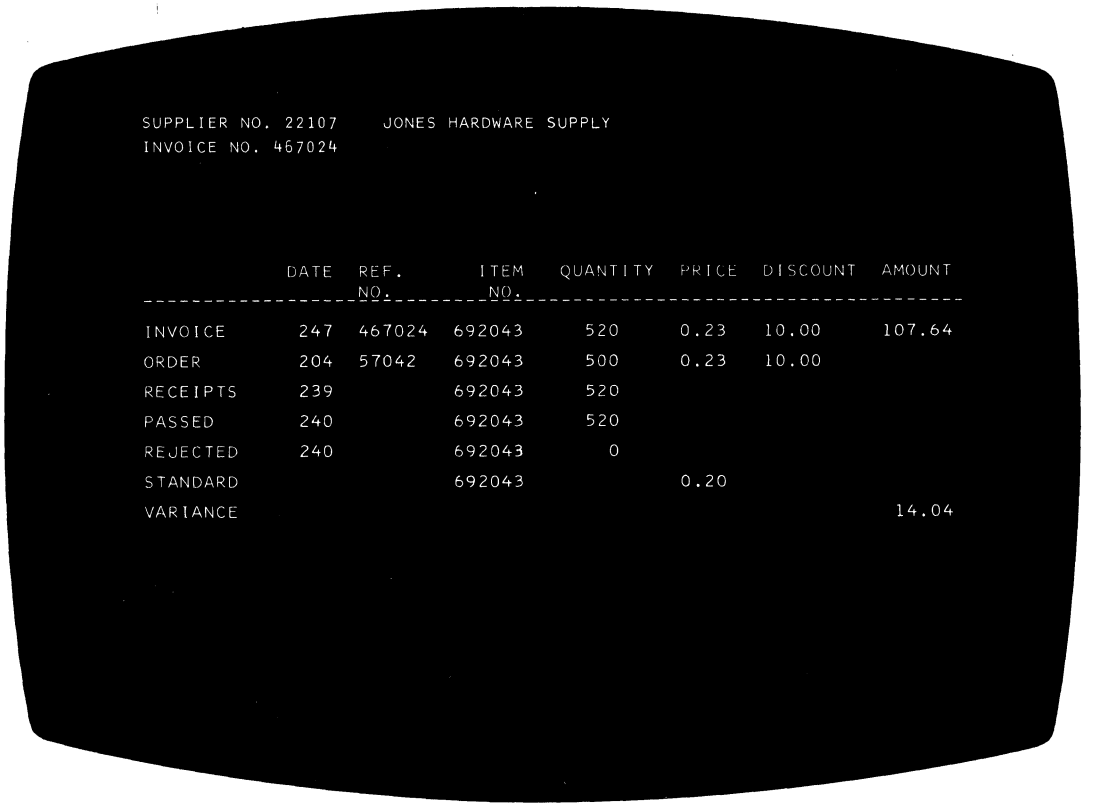


Figure 9. An example of the use of a terminal to match suppliers' invoices to purchase orders and receipts. It simplifies accounts payable processing

The advantages of computer matching of invoices are as follows:

- The invoice is registered and a control record created which can be automatically listed if the invoice is not cleared promptly.
- All the information needed for verification is rapidly provided to the clerk at the terminal. Discrepancies between ordered, delivered, and invoiced quantities, prices, and discounts are quickly recognized.
- Price variances based on current standards are calculated automatically. At the same time variances are accumulated by buyer and by product, and if cumulative variances exceed predetermined limits, they can be displayed automatically.

In addition, a costed bill of material can be displayed showing the cumulative effect of current purchase prices on product costs. Therefore, a close control is obtained over material price variances, and a review of material standard costs can be undertaken if needed.

Usage variances

Material cost variances in a standard costing system may result from excessive (or less than normal) scrap in the shop, or from the effect of changes in the material cost of the product that have not yet been incorporated in the standard.

Actual cost information is available as soon as production of a part or assembly is completed. PLANT MONITORING AND CONTROL provides the information listed in "Direct Labor Cost Control", at the end of each individual operation. This information enables the material value as well as the labor value of the work-in-process to be updated immediately. Also available at order completion is the net quantity produced. This makes it possible to calculate the standard material cost of the quantity produced, by reference to the standard cost data in the item definition data base.

The actual usage of direct materials and purchased components is calculated from stores requisitions processed. This information is created by STORES CONTROL when the material is issued and the material value is calculated at standard cost.

Quantity variance is first isolated by comparing the actual material cost with the standard cost for the bill of material used. If there has been an engineering change, the reason code in the standard cost change record identifies the engineering change. The effective date of the engineering change will match the effective date of the standard cost change.

Engineering change variance will account for the remaining difference between the actual material cost and the basic standard cost. This variance is obtained by comparing the standard cost for the current engineering change level with the basic standard cost. Figure 10 illustrates the separation of quantity and engineering change variances. These variances are summarized by product and by work center.

Controlling Inventory Investment

The role of INVENTORY MANAGEMENT in the reduction of inventory levels was mentioned earlier. This capability is derived from the historical measurement of error in the demand forecast. A *safety stock* is established to provide protection against an out-of-stock situation during the replenishment lead time (see *Chapter 5, Inventory Management*).

The other principal factor influencing inventory levels is the size of the order, which is usually calculated so as to create the minimum combined cost of acquiring and maintaining inventory.

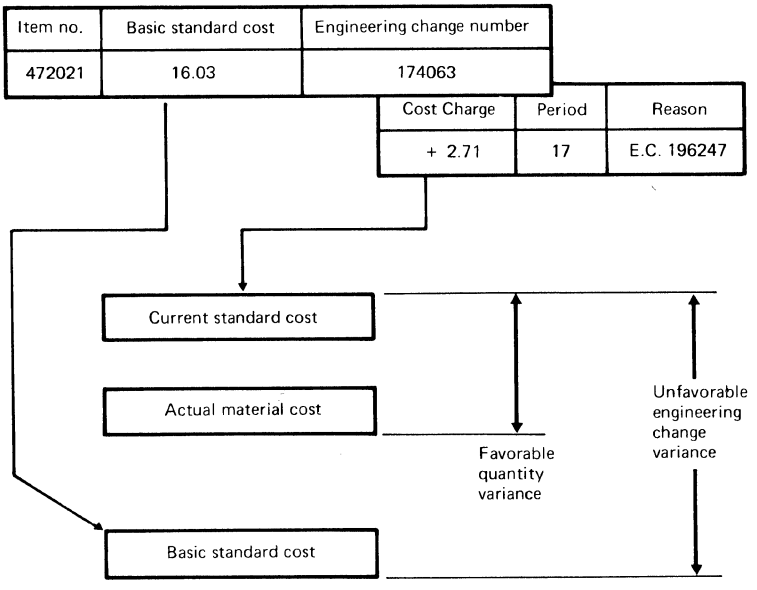


Figure 10. Variances in material cost are separated into those attributable to production and those attributable to product changes

Calculation of safety stock and order quantity requires cost information, such as the cost of financing, storing, and acquiring inventory. An inventory management policy also requires a marketing evaluation of the probable profit or cost to the company of changes in the level of customer service. This provides the ability to choose an optimum level of inventory and customer service. These controlling factors are then used by INVENTORY MANAGEMENT, which maintains the lowest level of inventory consistent with the chosen customer service level. The accounting and marketing evaluation of the available alternatives is a key step in arriving at an inventory control system that is responsive to management's objectives.

Work-in-process inventory can absorb much of a company's funds unless it is satisfactorily controlled. The system also aims at the reduction of work-in-process to the maximum extent consistent with efficient plant operation.

The control of capacity level and of the release of work to the plant, discussed in *Chapter 6, Manufacturing Activity Planning*, reduces work-in-process by the maximum amount without increase in the amount of work center idle time.

Data provided by PLANT MONITORING AND CONTROL enables the current value of work-in-process to be maintained continuously. Since direct labor variances are also continuously monitored, the relationship between work-in-process value and shop efficiency for varying levels of

production can be determined, and the optimum balance identified. This enables work-in-process inventory value to be predicted more accurately when changes in the level of production are forecast.

Firm purchase commitments can be calculated when purchase orders are about to be placed. At this time a firm forecast of material prices, quantities, and deliveries becomes possible. Consequently, future spending on additions to inventory can be accurately forecast when the purchase requisitions are created. Planned purchase orders are developed by INVENTORY MANAGEMENT and passed to PURCHASING by ORDER RELEASE. Normally they should not require review or alteration. However, INVENTORY MANAGEMENT is concerned with forecast requirements and minimum inventory acquisition and maintenance costs. It does not consider cash flow, or arbitrary limits on inventory value, which may be temporarily imposed for financial reasons. During critical periods it is common for management to use arbitrary rules, such as reducing inventory by a fixed percentage, or monetary value. If the controller is provided with the cash effect of purchase requisitions immediately before orders are placed, this level of control becomes possible.

PURCHASING provides a forecast, based on requisitions created, current prices, and invoicing and payment cycles, of the cash flow required for additions to inventory over the period covered by current orders. By making this information available before orders are placed and the money is committed, the financial forecast of inventory level can be compared with the original plan and with the cash resources that will be available. Out-of-line situations can be prevented by varying purchase quantities and dates, the extra costs or the exposure to out-of-stock situations being known and evaluated against the overriding financial requirement. This degree of control is of particular value during a period of heavy capital investment which is being financed from income.

Long-range planning of material and inventory costs is discussed under "Allocating Company Resources".

Under the traditional method of arriving at product costs, those that can be associated directly with an individual item or product are separated from the remaining indirect, or overhead, costs. These direct costs have often been limited to direct labor and material costs. However, the increasing use of expensive automated equipment, with its high rate of depreciation and proportionally lower labor costs, has led many companies to regard machine tools also as a direct cost.

In a total costing system such as COPICS, this approach reduces the amount of overhead that must be distributed to products by less accurate methods than those used for calculating direct costs. The objective of the system is to distribute more cost elements directly to individual products, thereby improving costing accuracy.

The system provides detailed information enabling a number of cost elements to be controlled automatically in this way, and so helps provide the advantages of both traditional direct and total costing systems.

The cost elements discussed here are:

- Machine costs
- Machine setup costs
- Plant maintenance costs
- Materials handling costs

Machine Costs

Machine tool depreciation is often recovered as a proportion of direct labor cost. Today's more costly, automatic equipment usually reduces direct labor costs, while at the same time increasing depreciation. These trends can lead to less accurate product costs if the original basis for recovery is unsound.

With the COPICS approach, the data base contains a facility record for each machine tool. These records are grouped into work centers, and also into cost centers, if these are different from work centers. They include the asset ledger information, and consequently they can be used to maintain capital value and depreciation information, and to record maintenance and modification work that is capitalized onto the machine tool during its life.

Planned usage of the machine tool is recorded, by period, in the facility record, as part of the capacity requirements planning activities of MANUFACTURING ACTIVITY PLANNING. When standard costs are used, the job standards in the process description record refer to the machine tools or work centers that are used. Consequently, all the data is available that is needed to establish:

- The machine cost per unit time (machine hour rate)
- The machine cost for each operation

This allows machine tool costs to be planned as direct costs, in the same way as direct labor costs.

Manufacturing Activity Reporting discussed in PLANT MONITORING AND CONTROL provides for each transaction the shop order number, operation number, start and stop times, and the operator's number. The system's assignment of operators to individual machines enables the machine utilized to be identified. From this information the actual usage of the machine can be calculated for comparison with the standard usage.

The question of whether the machine-hour rate should be based on total available or total planned production hours is not discussed, since this is determined differently in each company. However, the information required for each of these methods is maintained by the production control system in the machine tool facilities record.

Using this information, standard machine cost can be calculated automatically and included in the direct cost of each item. Variances due to efficiency, lost production time, and time when the machine tool is not scheduled, can be identified and distributed to the appropriate expense budgets in the same way as direct labor and materials variances.

Machine Setup Costs

Machine setup costs may be included as part of the standard direct labor cost, in which case the actual cost will move up and down sharply if the batch size is varied. Alternatively, they may be considered as shop overhead but this hides the true cost of making small batches. The setup standard is created by the production engineer when the direct labor standard is created. Setups are reported to PLANT MONITORING AND CONTROL in the same way as production operations, and actual and standard costs are compared as part of direct labor costs.

When setup is performed by separate setup operators, not all of their time is reported as engaged on setups. There will inevitably be periods when they will be waiting between setups. Also, during these periods, they will be reviewing the status of running jobs, collecting drawings and tools, and sharpening tools; that is, they will be engaged in activities that do not require availability of the machine tool. This helps them better the standard during the machine setup itself, and it may be necessary to eliminate those work elements from the standards, and to plan for them to be carried out during waiting periods. Setup operators' time is therefore divided between the following:

- Setting up machines, which is considered a direct cost and performed against a standard for cost control purposes
- Waiting, which is considered an indirect cost and included in the shop manager's expense budget

Treating setup operators in this way does not completely eliminate an overhead expense item, but simply increases the portion of the total cost that can be attributed directly to a specific product.

Plant Maintenance Costs

Maintenance activities can be separated into planned and unplanned. The planned activities arise from scheduled maintenance, such as oiling, greasing, adjustment, parts replacement, and planned overhauls. The unplanned activities arise from emergency action to remedy a breakdown (see *Chapter 9, Plant Maintenance*).

Maintenance activity is planned and controlled by work orders for which standards or estimates are created. The maintenance work performed on the shop floor is reported in the same way that production jobs are reported in PLANT MONITORING AND CONTROL. Maintenance jobs, both planned and unplanned, are identified with the item of equipment being serviced, and start and stop times are recorded.

Consequently, both the planned and actual maintenance cost for an individual machine tool can be calculated, and any cost variance can be identified. The maintenance cost, standard (or planned) and actual, can be distributed on the same basis as the cost of the tool itself. In this way, the amount of maintenance cost ultimately distributed as an overhead is substantially reduced.

The remaining maintenance costs are made up of elements such as:

- Waiting time of maintenance men. This can be treated as an overhead or can be considered as the cost of having an adequate maintenance team on call. It can be distributed by the system with the planned maintenance costs on a percentage basis.
- Maintenance on general equipment, such as an air compressor supplying a complete shop, which can be treated as an overhead.

Materials Handling Costs

From an operational point of view, an important uncontrolled area has been the transport of batches of work between machine centers. The system provides a more detailed method for planning and controlling this activity, and thereby creates the possibility of closer control over the costs involved.

Standards for interoperation moves, based on normal batch sizes, can be established. These standards are recorded by creating a record for each interoperation move requiring transport facilities. Consequently, a standard cost for interoperation moves can be associated with each item in production. Control of the actual costs is achieved through a reporting system that continually monitors jobs waiting to be moved and the location and availability of transport facilities (see *Chapter 8, Plant Monitoring and Control*).

Each move is reported, and for each the order number, item, transport facility, start and stop times, and locations are recorded. From this data the actual cost of transport per batch and per unit can be calculated. When mixed loads are carried, the cost of each batch can be calculated from the total transport cost on the basis of weight or volume. This information is stored in the shop order record when it is created.

Waiting and unproductive transport time can be handled as an overhead, while the actual costs reported are handled as if they were normal direct costs. The same method can be applied to interplant transport.

The management of overhead costs involves three separate but related phases:

- Establishing and controlling departmental expense budgets
- Distributing nonproductive departmental expenses to the productive departments as overhead
- Allocating productive department overheads and expenses to products

The aims of the expense accounting system are illustrated in Figure 11.

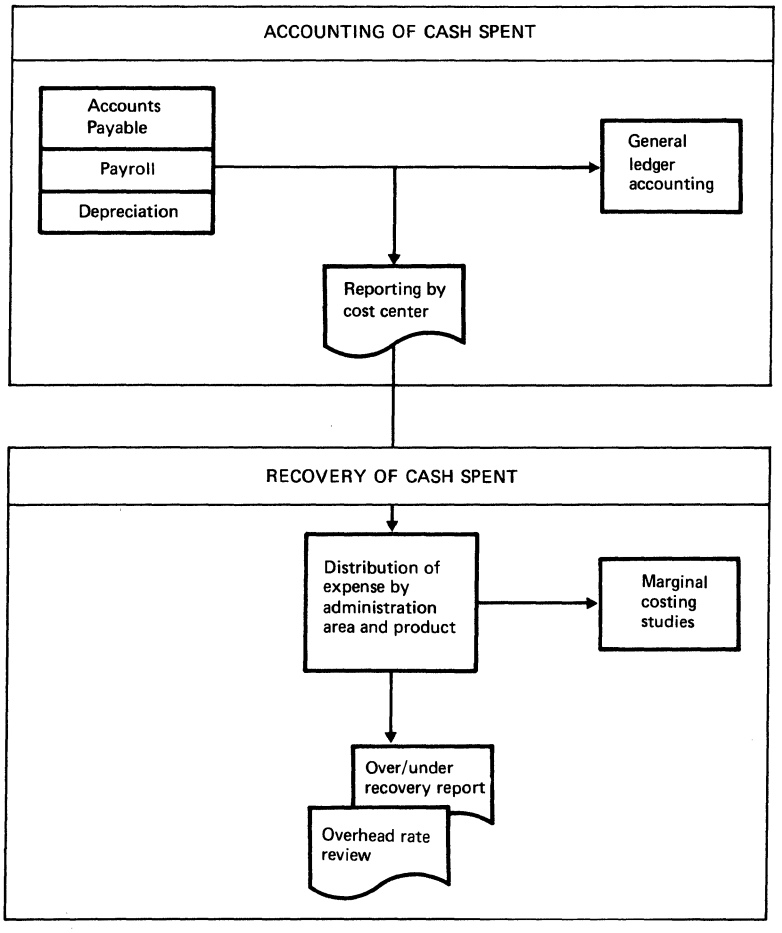


Figure 11. Overhead costs are controlled through departmental expense budgets and recovered by distribution to products

The principal objective is to account for all expenses by area of responsibility and by product. To accomplish this, expenses for a planned level of sales are forecast by departmental managers, and actual expenses are measured against these plans through departmental or cost center budgets. The impact of overhead costs on products is then assessed by distributing departmental expenses to products on the most equitable basis available. This provides a basis for product pricing and ensures that expenses are recovered through sales.

The tools used to plan and control expenses are the cost account codes and the cost center organization:

- Account codes are allocated to all items of expense on which information is needed for control purposes. In a computer-based system the cost codes can be as detailed as necessary for effective cost control.
- The cost center organization allows expenses to be summarized by area of responsibility. A numeric code is used to identify every area for which unique controls are required. These areas often coincide with departments, but a computer-oriented system facilitates the further subdivision of departments in order to control spending by managers at lower levels. Cost center organization can also be affected by the distribution of expenses to productive departments, described later. The only criteria in defining cost centers are that the cost be significant, and that the area of responsibility be clearly defined.

Planning Departmental Costs

The basis of expense control is the cost center budget, in which the manager responsible makes a detailed forecast of his expenditure for each account code item, for the planned level of manufacturing activity.

The development of good departmental budgets is hindered by the fact that a budget created solely by a cost center manager will often contain some "slack" as an insurance against unforeseen difficulties, whereas a budget created by accountants may not result in complete commitment by the cost center manager. A satisfactory budget can be created by a compromise between these two methods. Finance can assist by initiating a forecast of probable expenditure for each cost center, which is then completed by the cost center manager.

Relationships between costs and activity levels can be developed relatively accurately, on the basis of current operating methods, from accounting ratios, such as:

- Cost per man employed
- Cost per square foot of space occupied

- Cost per unit sold
- Cost per unit purchased

When these ratios are used in conjunction with sales and production plans, detailed budgets for every cost center can be created.

These ratios are fully adequate for planning long-range budgets. They are likely to be at least as accurate as the long-range sales forecast, and since the objective of long-range budgets is to provide a basis for planning, not a current operating plan, departmental managers need not be committed to them.

However, for the short and medium term also, these ratios can be used to produce an initial budget forecast. This becomes the basis on which departmental managers complete their detailed budgets.

Accounting ratios assume an unchanging relationship between costs and levels of activity. Cost relationships are usually more complex than this, and it is often necessary to find the degree of correlation between the cost and the activity. When the relationship depends on a single factor, but is not represented by a straight line, it may be found by plotting historical information in the form of a graph.

Figure 12 shows the cost per employee of providing a cafeteria, and also the total cafeteria cost, both related to numbers of employees.

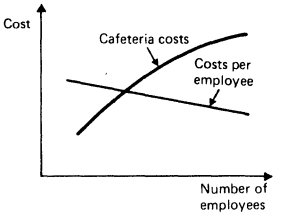


Figure 12. Cafeteria cost per employee reduces at a fixed rate as the number of employees increases

More complex relationships can be identified using the statistical technique of *multiple regression analysis.* The use of regression analysis for forecasting demand is described in *Chapter 3, Forecasting.* This same technique can be used to identify cost relationships when multiple related factors are involved.

Multiple regression analysis is most useful when the presence of multiple factors is known but when their effect cannot be measured. This happens when the factors related to cost move independently of one another but only the total cost is available. Examples include:

- Electric power used for lighting in offices and plants, and for machine power and process needs such as furnace heating, when there is inadequate separate metering
- Fuel oil used for building heating and process heat, and provided from a single boiler installation
- Water used for domestic needs, and for industrial cooling, from a single metered supply

Departmental expense budgets can be stored and maintained by the data base facilities used by the system. Planned expenditure for each cost code, for each accounting period, is stored in a cost center budget record. The records are connected in the same way that the department's costs are structured. Figure 13 illustrates part of the expense budget of a personnel department.

During the formulation and revision of budgets, the clerical work involved in consolidating budgets at higher levels is performed by the system. The technique used in the product definition data base to consolidate end item direct costs is used to automatically summarize the costs at each level into the record at the next higher level. Using this technique, individual expense budgets are summarized into departmental, divisional, and company totals, retaining account code identification at each level.

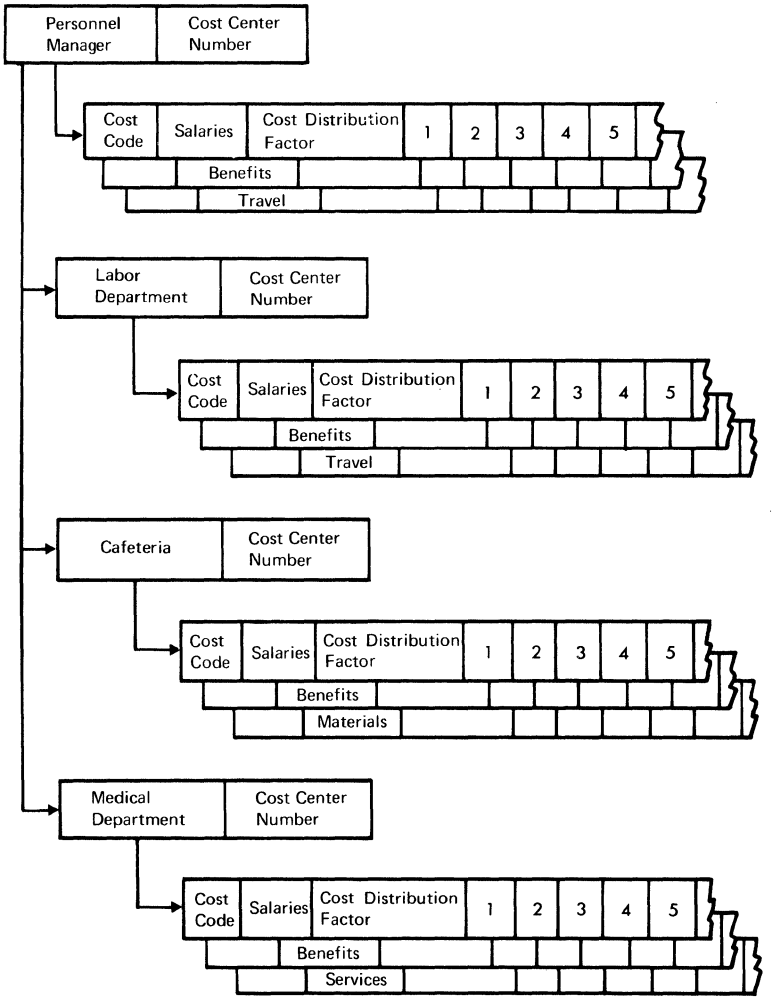


Figure 13. A departmental expense budget contains agreed-upon forecast spending for each cost center, for each cost code, for each period

Actual expenses are summarized by account code and cost center code. Each accounting period, the results are reported to managers and compared with their budget amounts under each account code, both for the period and for the year to date. Further details required by top management can also be produced, for example, expenses summarized by major account code.

Developing Product Costs

Product costs are developed by allocating the total expense represented by expense budgets to the individual products, and combining these distributed expenses with the direct costs of the products.

Most current systems of product costing use principles that are simple and well established. Expenses of all indirect cost centers are distributed to the productive departments, and the total distributed expense is applied to the direct cost of products, often on a simple basis, such as by increasing direct labor cost by a fixed percentage. The result of such a method is that a product with a high labor cost carries a high overhead, whereas a product manufactured largely on automatic machines carries a low overhead, even though the cost of the machines is high. Most simplified methods of overhead cost distribution result in equally misleading product costs, when a varied product line is manufactured.

Distribution of Overhead Costs

When the distribution of overhead costs is performed by a computer-based system, each cost can be considered individually and distributed by the best available method. There is no need, as there is in a manual system, to limit either the number of costs to be distributed or the number of different factors on which distribution is based. The amount of calculation created when more detailed distribution of overhead costs is attempted is insignificant. Equitable distribution, therefore, can be the overriding consideration.

The following considerations apply when organizing computer-based overhead distribution:

- Cost centers are assigned to a distribution group that determines the sequence of distribution. The most indirect cost centers have the lowest distribution group number, and their costs are distributed to all other indirect and direct cost centers first. The medical department and cafeteria are typical examples of departments in the lowest distribution groups. Each higher-level group is distributed in turn, until all overhead costs have been absorbed by the productive departments. This is illustrated in Figure 14.

- Each cost center is assigned a distribution factor that provides the basis on which its costs will be spread to higher-level distribution groups. Examples are numbers of employees, floor area, standard labor hours, and standard machine hours.

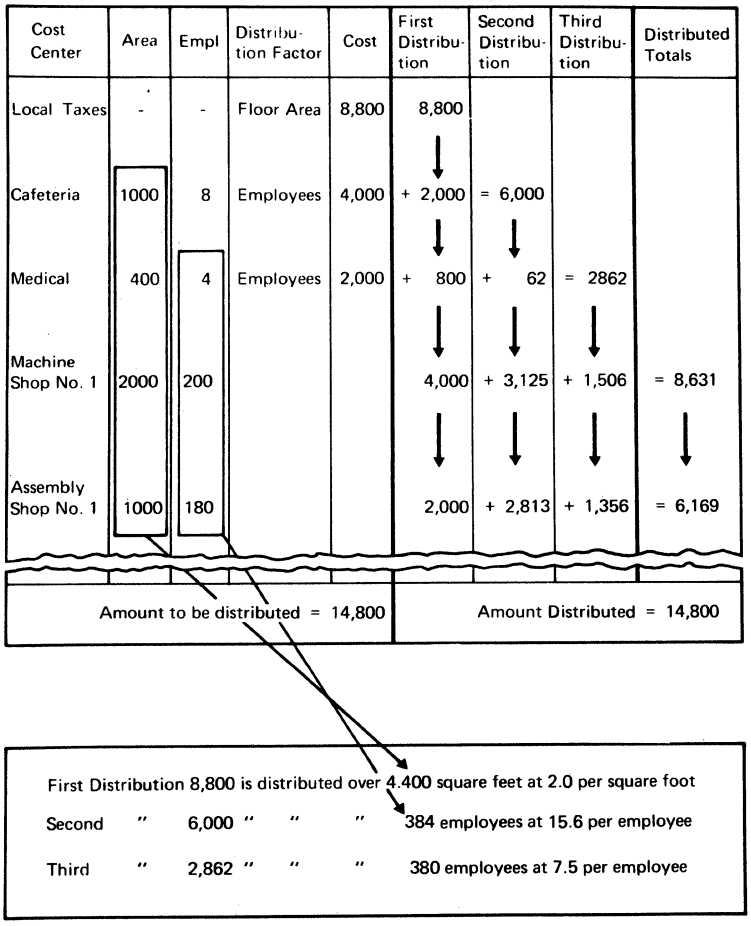


Figure 14. Overhead costs are spread to cost centers in the more direct distribution groups on the basis of distribution factors

Since all of the work involved in distribution is quickly performed by the system, there is no limit to the number of distribution groups and factors that can be used.

This improved overhead distribution may affect the designation of cost centers; elements of a department's costs that should be distributed to different parts of the company on the basis of different distribution factors can be separated into different cost centers. For example, personnel department costs may include the following elements:

- Plant personnel department, which may be directly related to the number of plant employees and therefore be distributed to plant departments on that basis

- Employee benefits, which may be directly related to total payroll cost and therefore be distributed to all departments on that basis

This distribution can be achieved by ensuring that plant labor office and benefits are separate cost centers with different distribution groups and factors. Distribution of expenses to productive departments can thus be achieved on a significantly more realistic basis.

Overhead Cost Recovery

The total overhead costs of a productive department or cost center (that is, the department's own overheads as well as the overheads distributed to it) are recovered on the basis of the production output of the department. For example, the basis for this distribution might be:

- Assembly shop – direct labor hours
- Machine shop – direct machine hours
- Foundry – weight of castings
- Plating – weight of items
- Heat treatment – number of items

Using this basis, the total overhead in assembly would be distributed to each operation performed on each item in the work center, in proportion to the direct labor hours required for the operation.

Total item overhead is therefore made up of individual overhead amounts, calculated on the most suitable basis for each operation, thus providing a more equitable distribution. End item overheads are accumulated through the bills of material, from the overheads of all components incorporated in the end item, using the method employed to develop end item direct costs (see "Direct Labor Cost Planning").

Product mix and volume changes can have a significant effect on the overhead distributed to individual products. The volume of calculation in the resulting overhead rate review is no longer a problem when it is carried out by a computer-based system.

The financial executive, in his company planning capacity, is involved in most situations where alternative objectives compete for the use of company resources. These include:

- Evaluating both short-term and continuing objectives that conflict with each other – for example, comparing the cost of maintaining levels of work-in-process against the cost resulting from a reduction of operating efficiency because of no work.
- Evaluating long-range plans where increases in sales volume may result in competition between products, and divisions, for capital investment and cash resources.
- Evaluating individual capital projects.

Controlling Conflicting Demands for Current Resources

The system generates production material requirements and the manufacturing load these requirements place on resources. The system would work perfectly, were it not for the random events that upset all production plans. Sales are higher or lower than expected, suppliers deliver orders later than requested, and machines break down. The average incidence of such events can usually be found, and by allowing a "buffer" in the form of additional inventory or spare machine capacity, a certain proportion of these situations can be covered. Buffers could be established to cover all possible situations. But would the costs be affordable?

In many parts of the system, buffer size is controlled by the application of simple statistical methods. These are based on the ability to measure the frequency with which an event varies above and below the average situation. For example, the average number of men needed for emergency maintenance work may be 9. Investigation may show that the probability of the number required being 10, 11, or 12 (to work on simultaneous breakdowns) is as shown in Figure 15. This distribution of requests for maintenance men shows that 79% of all requests could be met by 10 men, 95% by 11 men, and 99% by 12 men.

The costs of not meeting 1%, 5%, and 21% of requests can be estimated and compared with the cost of 12, 11, and 10 men respectively, so that the most economical level can be chosen and the maintenance team brought to this number.

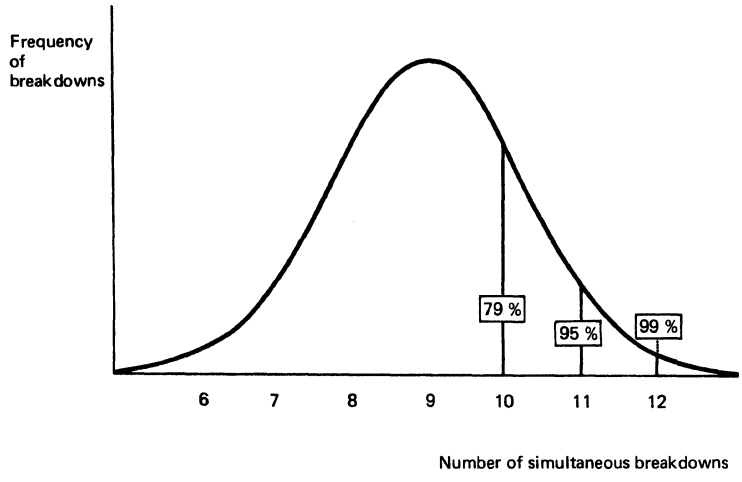


Figure 15. Increasing the size of the emergency maintenance team allows a known additional percentage of maintenance requests to be satisfied without delay

This technique can be used to measure the value of many buffers, and to control them – for example:

- The queue of work in front of every machine absorbs fluctuations in the arrival of work and helps ensure that machine and operator are not idle. Using statistical techniques, queues can be reduced to just before the point at which idle machine and operator time are projected to occur. This subject is discussed fully in *Chapter 6, Manufacturing Activity Planning.*
- Labor pools are often created to absorb fluctuations in workload. The emergency maintenance crew is an example. Measuring the variation in the demand for maintenance men permits the pool to be reduced until the combined cost of the pool and the failures to provide maintenance is at a minimum. *Chapter 9, Plant Maintenance* contains a description of the technique for sizing standby maintenance labor crews.
- Safety stocks absorb fluctuations in the demand for items during the time needed to obtain a new order, and reduce the likelihood of out-of-stock situations occurring. Measuring the fluctuations in demand during the replenishment period enables the safety stock to be sized to permit only a predetermined level of out-of-stock situations. For further details see *Chapter 5, Inventory Management.*

In present systems, buffer size is usually not planned; buffers just expand until their costs become excessive and a crash effort is made to reduce them. Usually they are large enough to prevent the department concerned from being criticized for providing an inadequate service. Analysis and calculation of the optimum buffer size often results in a significant reduction in cost. Identifying these buffers

and their associated costs, and evaluating the "trade-off" between different buffer sizes, requires the help of the financial department. When the criteria controlling buffer size have been established, the buffer can be managed dynamically by the system. An example is safety stock, where an increase in the inaccuracy of the demand forecast automatically creates a compensating increase in the level of safety stock so as to maintain the same level of service.

Production priority systems offer further opportunities for selection between alternative objectives. Their basic aim is to force important or late orders through production on time. Priorities are adjusted automatically to respond to changing conditions in the shop.

Establishing management standards through the system's statistical capability provides a more realistic basis for cost control, when the number of individual cost elements is high. For example, expense budgets of production departments include provision for many variance items, such as lost time due to machine breakdown, shortage of materials or tools, or indirect work performed by production workers. Attempts to control and reduce these excess costs are often frustrated by their volume. The performance levels established are often the same from one department or process to another, although, since each is different, each one should be forecast and controlled separately.

When *actual* cost data is being reported by PLANT MONITORING AND CONTROL, the system can collect and store the detailed cost information and calculate averages, deviations, and trends using the techniques discussed in *Chapter 3, Forecasting.* This information serves as the basis for initial standards for each production cost center. Subsequently these standards can be raised or lowered on the basis of actual cost trends reported by the system.

In addition to normal reporting of all departmental costs on a periodic basis, the system has facilities for displaying important out-of-line situations as soon as they are recognized. This is achieved through the concept of managers' Action Files (see *System Requirements*). Using Action Files, excess costs can be reported when they exceed the standard or budget amount by a predetermined percentage, or by a fixed absolute amount. The percentage or absolute amount is a management-selected control figure that can be adjusted whenever necessary.

Adjustment allows management to respond to an improving cost situation by lowering the excess cost level at which reports are generated. At the same time, the volume of data can be controlled so that the amount of information competing for management's attention does not exceed their capacity to react.

This facility provides management with a "fine tuning" capability for the control of out-of-line situations, since small adjustments to the control numbers can be made at any time to suit changes in management objectives.

Long-Range Planning

The level of accuracy attempted in long-range profit plans depends on the purpose of the plans, which is, usually, to provide management with guidelines for profit, investment, and cash flow for future years. Consequently, the goal is not extreme accuracy, but rather an attempt to develop good, achievable targets for company profits and growth.

FORECASTING and MASTER PRODUCTION SCHEDULE PLANNING provide a basis on which such plans can be developed. These plans are easily maintained to reflect changes in management's objectives. The major elements in establishing long-range profit plans are sales income, direct production costs, and indirect costs.

Sales income for future years is based on the forecast of sales demand provided by FORECASTING. For production purposes, the forecasting horizon is determined by the need to plan material availability in sufficient time for manufacturing requirements. However, this horizon can be extended further to provide advance warning of additional capacity requirements and a basis for financial planning.

The system can project future sales income automatically on the basis of forecast demand and current prices for each period within the planning horizon. Planned or probable price changes can also be included by using the method described earlier for controlling changes to standard costs.

Direct production costs are developed from the master production schedule volumes. This schedule is created by MASTER PRODUCTION SCHEDULE PLANNING from the sales demand that has been forecast. It provides the basis for all production planning activities. For the immediate future it represents a detailed production plan for all end items (products and service parts), by period, through the materials planning horizon. For long-range planning it maintains production requirements for groups of products. MASTER PRODUCTION SCHEDULE PLANNING also maintains weighted average direct costs for these product groups, calculated from the current and planned direct costs of the individual products in each group.

The use of product groups enables a satisfactory level of accuracy to be attained for long-range planning purposes, while avoiding the large volume of calculation needed for detailed planning of individual products.

Indirect costs involve the development of expense budgets through the planning horizon. Commitment to these budgets by cost center managers is not necessary when planning for the period up to two to five years ahead. Since the information obtained from the long-range plans is used mainly as a basis for management decisions, the most important requirement is to be able to regenerate the budgets rapidly so as to reflect significant changes to expenses arising from:

- Volume changes
- Changes to capital investment programs which affect product costs
- Introduction of new products
- Changes to pricing policy and marketing strategy

The reduced level of accuracy which is acceptable enables fast methods of budget generation to be adopted. The methods discussed under "Controlling and Recovering Overhead Costs" for the creation of initial department expense budgets are adequate for these long-range plans. These include:

- Simple accounting ratios, such as the cost of employee benefits as a percentage of payroll cost, where the relationship does not change.
- Simple correlations such as building maintenance cost per square foot of floor space in use, where the unit cost may be reduced as the area increases.
- Multiple correlations such as in the case of fuel oil cost, which is affected by many factors, each of which affects the total cost differently.

To satisfy the objectives of long-range planning, more accounting ratios may be needed than are normally used for planning current budgets. For planning in a time frame of two to five years in the future, simple ratios, such as the cost of indirect shop labor as a percentage of direct labor, are usually adequate. An unlimited number of these can be created, the sole criterion being that they provide a satisfactory relationship between cost and level of activity, for long-range planning purposes.

They can be modified by management judgment to reflect internal changes, such as to manufacturing methods, as well as external changes and economic trends. The accounting ratios are then applied to forecast volumes and activity levels, by cost code, within cost center, to enable full expense budgets to be assembled.

Planning and Controlling Capital Expenditure

Although capital expenditure is planned and controlled independently of the current operating plan, both capital and revenue income and expenditures must be considered together. The reasons are that:

- Financing of a major capital project requires a large cash flow that may be planned from current income.
- Completion of major phases of the capital project determines the point within the financial year when depreciation begins.
- Each section of the project determines the point in time at which profits are affected by such things as sales of a new product or changes in manufacturing or warehousing costs for an established product. These changes must consequently be applied to current operating standards and budgets.

The system helps in the planning and control of capital expenditure by enabling some of the most important calculations to be performed automatically.

The *asset ledger* (Figure 16) is part of the facilities data base. It contains the original cost, the current book value, and the depreciation method and period, so that the current book value can be updated automatically. The asset can be identified by:

- Asset type – for financial reporting
- Location – for physical verification
- Cost center – for recovery by product

The current asset value is always available in the facilities data base and can be obtained by individual machine, or by cost center, or by total assets.

For planning purposes, this record can be created when purchase of the asset is first approved. Subsequently, any change in expected project completion date can be reflected by a simple change to the planned installation date in the asset record. After that the system can rapidly calculate future depreciation, by period, by items produced, or by productive hours.

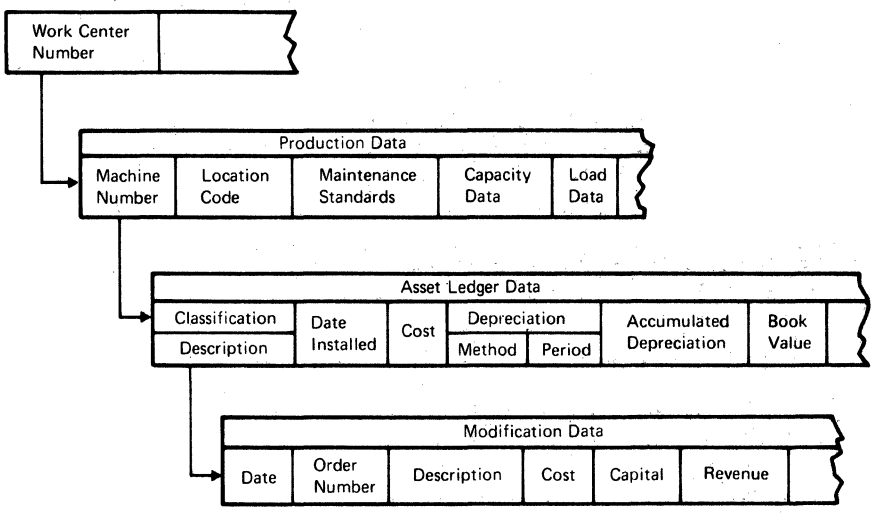


Figure 16. The facilities data base record contains asset ledger information

Future demand is provided by FORECASTING. The system can calculate the direct cost of items and products affected by proposed capital projects, for each period through the long-range planning horizon, on the basis of current costs and the forecast volumes. The calculation can then be repeated, after the anticipated cost changes have been entered in the appropriate item records. The differences show the effect on profits, by period, of the planned changes to direct costs.

Evaluation of capital projects

Using discounted cash flow methods, the system can calculate project profitability from the cost and profit information that has been generated. Avoidance of a large volume of calculation when this information is generated and evaluated automatically, provides a substantial advantage over manual methods. The greatest advantage, however, is that these calculations can easily be performed repeatedly when the capital cost or the effect on operating costs changes during project development and refinement. Repeated calculation also enables management to discover what level of sales, or cost saving, must be achieved to provide the lowest acceptable return on the invested capital, if the current estimates are not realized.

Control of capital projects

During the life of a project, changes to scope, cost, or timing may develop. The effect of these changes on company profits can be quickly determined by updating the capital cost and product costs and recalculating the return on investment.

Manufacturing product cost is subject to variation from capital overspending (which ultimately affects the product through higher-than-planned depreciation), from higher-than-planned labor and material costs, and from failure of the facility to ultimately achieve the planned capacity. Regular project review is essential in order for such changes to be incorporated in a revised capital evaluation, and in revised operating budgets, as soon as they become apparent.

Project cost increases can be minimized or avoided by the use of project control techniques. These techniques employ well established critical path methods to use available resources efficiently and to predict and hold to realistic project completion dates. The effect of project changes on completion date and total cost, as well as on spending rates, can be reviewed regularly when the project plan can be rapidly updated by a computer-based system.

Summary

COST PLANNING AND CONTROL helps the financial executive develop more accurate and comprehensive financial plans, and to control expenditure against these plans on a more realistic basis. It concentrates on those functions where the system makes a significant contribution to improved cost information. Assistance in planning and controlling costs comes in a number of ways:

- Functions are carried out within the production system which relieve the controller of the need to set up special control systems.
- The basic data for many costing systems is created and made available during the planning and manufacturing cycle.
- The manufacturing data base provides a framework for organizing the costing data.
- The computing system enables more detailed and accurate cost control techniques to be used.

Emphasis is placed on the financial executive's dual role, namely, his financial responsibility and his function as a member of the management team. The latter involves establishing management standards and selecting policy rules used by the system.

The advantages of COST PLANNING AND CONTROL include:

- Improved quality of the source cost data
- Reduction of delays in processing cost data, and subsequent reruns, caused by the rejection of source data
- Reduction of reconciliation problems leading to faster availability of cost information
- Better control over cash flow through advance spending forecasts
- Management decisions based on more factual information obtained through the use of simulation
- Improved methods of overhead distribution

Notes

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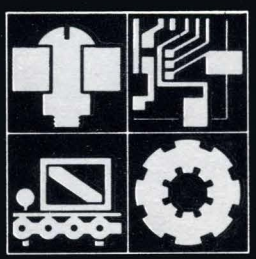

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