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Automated Inventory-Production Control

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Technological change in a component part? Too high a parts inventory? Common problems—but here's one solution that's working—one company's

AUTOMATED INVENTORY-PRODUCTION CONTROL

by Robert M. Smith
Editor

THE COMPANY making a simple product with only a few parts does not have much of an inventory problem. If it produces against orders which permit a fairly generous time lead, it has practically no problem at all.

But a company making several extremely complex products, each of which requires thousands of component parts, has a very severe inventory problem. Any failure to anticipate precisely the parts required, the time at which they will be required, and the quantity that will be required can cause production breakdown and failure to fulfill orders on time. Yet engineering changes can obsolete any given part of the finished product on a moment's notice; so carrying huge inventories of parts is no answer. And, of course, overly large inventories are a heavy drag on capital in any event.

That is the reason that the more technical the product a company makes, and the more subject to constant design change and improvement, the more the company needs to control its parts inventory as carefully as possible. Each such company faces much the same problems in terms of complexity of product and constant design change. Many have met the problem in much the same way.* And each of the systems worked out can serve as a rough model for any company which has an inventory problem and which also has access to an on line-real time data processor.

Let's examine one such system in detail:

The Burroughs Corporation Electrodata Division in Pasadena, California, the first of the company's plants to develop and install the new inventory system, had three basic concepts in mind in evolving its ACTION program:

Control cannot be exercised over something that has happened in the past. Control is a concept of the future.

To control is to manage.

Inventory control, production control, and scheduling are inter-

* Examples: International Business Machines, Lockheed-Marietta, Caterpillar Tractor, Burroughs Corporation.

PARTS LIST

PLANNER G AREA ENG. P MANUFACTURING DATE 10/15/63

ADD	ENG. ITEM	MFG. ITEM	PR	IND	PL	DWG SIZE	PART NUMBER PRIME	PART NUMBER DASH	PART NUMBER SUB	DESCRIPTION	QUANTITY	U/M	CODE	MFG. LEAD	LOCATION ZN	LOCATION LN	LOCATION S	LOCATION BN	REMARKS
		10		0	PL	ND	11092277	000	~~A01~~ A02	FRAME ASSY 21 CONN	1	EA	MKE		40				
		15		1		D	11998259	000		FRAME 21 CONN BLOCK	1	EA	BY		40	F	B		
		20		1		C	11096179	000		STRIP 35 PIN GND	6	EA	BY		40	F	B		
		25		1		C	11942117	000		GND PLANE ASSY CONN	21	EA	BY		40	F	B		
		30		1		B	11944451	000		INS GND PLANE	18	EA	BY		40	F	B		
		35		1		B	11971231	000		CLIP CONN BLOCK	6	EA	BY		40	F	B		
		40		1		B	11971744	000		GROMMET-INSULATOR	12	EA	BY		40	F	B	10	
		45		1		S	11025996	000		SCR 6-20X5/8 HEX	24	EA	BY		40	F	A	12	
		50		1		S	11025947	000		SCR 4-24X5/8 HEX	~~12~~ 24	EA	BY		40	F	A	11	
		~~55~~		~~1~~		~~ST~~	~~12561122~~	~~000~~		~~SCR PAN HD 8-32X1/2~~	~~6~~	~~EA~~	~~BY~~		~~40~~	~~F~~	~~A~~	~~13~~	
		60		1		ST	12565263	000		NUT 8-32 HEX	6	EA	BY		40	F	A	14	
		65		1		ST	12568036	000		WASHER PLAIN #8	6	EA	BY		40	F	A	15	
		70		1		ST	12567731	000		WASHER IT LOCK #8	6	EA	BY		40	F	A	16	
		75		1		B	11096161	000		BAR GND 6 HOLES	1	EA	BY		40	F	A		
		55		1		ST	12561130	000		SCR PAN HD 8-32X5/8	6	EA	BY		40	F	A	13	

The Area Engineer checks the Manufacturing Parts List for every upcoming order; "red lines" a part to be deleted; enters new specifications at bottom of sheet.

related manufacturing control functions, which, taken together, encompass nearly all of manufacturing management.

System characteristics

The system evolved by Burroughs has three main characteristics:

All significant manufacturing transactions are recorded on magnetic tape and disk files in the plant's Burroughs B280 computer. No manual files at all are kept independently.

The system depends heavily on "turn around" documents -- computer-produced documents calling for action on someone's part. When the action is completed, it is noted on a data transmission device and so entered into the computer. This automatically updates the computer file.

All input to the computer, and all output from the computer, are in simple English, understandable both by men and machine.

Although there are considerably more than 200 computer applications incorporated in the ACTION system, calling for several different information files on tapes or disks, the two most important files in the plan are the parts list file and the inventory file.

Parts list file

The parts list file lists each of the component parts needed in a computer assembly. Since the listing entered on tape is the only record of the parts needed, it is the single controlling record for the Manufacturing Division—the master file.

The Manufacturing Parts List computer file is used to:

Print out parts lists for engineering and manufacturing (see replica above)

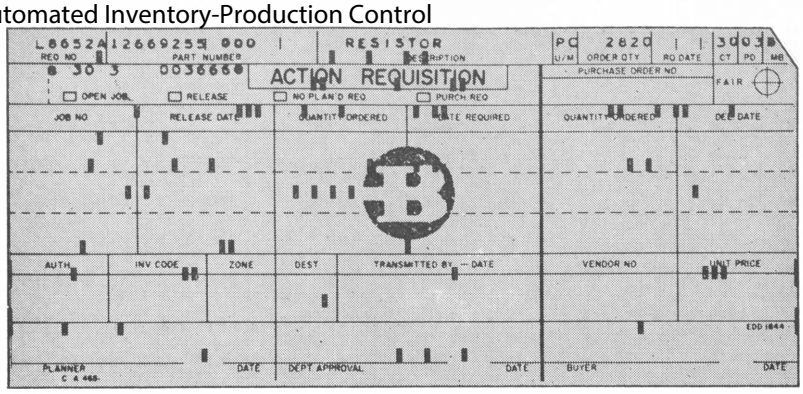
Maintain control over changes in specifications

Print "where used" listings

Compute forecasts and other special analysis reports

Explode production reservations for the inventory file.

The original printout of the parts list is held in Document Control; copies are sent to the planner responsible for producing the assembly and the Area Engineer responsible for maintenance of the parts list records. The Area Engineer checks the parts list for every upcoming order and makes any changes or deletions due to technological changes. If there are such changes they are noted on the engineer's copy of the list -- the old component is lined out and the replacement component written in in its place. The document is then returned to the computer center where the changed information is key punched for entry into the



If more components are required than are available in Inventory Available Balance, computer prints out Action Requisition Notice.

The inventory file is a four-balance inventory—quantity of parts on hand, quantity on order, reserved quantity, and available balance.

computer file. When the computer has accepted the new information, the file is automatically updated.

"When" is the operative word. The computer does not automatically accept engineering changes without first testing them. Duplicate additions or deletions are rejected by the computer automatically. The part number addition or substitute called for by the Area Engineer is checked by the data processor to ensure that a valid part number has been used. Only when these and other tests programed into the computer have been passed is the change made on the master computer file.

In this way, the parts list file is maintained. Each day a new parts list is printed for every assembly in which there has been a change of components.

This updated parts list is supplied to the Manufacturing Division whenever a change or addition has been made. Manufacturing thus always has a current parts list for each assembly.

When Manufacturing receives a production authorization for an assembly, the parts list is used to produce an explosion of production reservations in the computer inventory action file. Parts list quantity is multiplied by job quantity to find reservation quantity—the number of parts or assemblies required to fill a given job order. The quantity of units or assemblies to be produced is exploded through the parts list file to establish "reservations" for all the parts and subassemblies that will be needed to fill the order.

Inventory file

The inventory file is a four-balance inventory—quantity of parts on hand; quantity on order, whether acquired through internal production or outside supplier; reserved quantity—the portion of on hand and on order supplies already designated for a scheduled use; and available balance—the quantity remaining when reserved quantity is deducted from on hand and on order totals.

The Reservation Tape System dates each reservation and these are filed on the master inventory file in date sequence.

What Burroughs terms the "four-balance formula" is thus:

On hand quantity plus on order quantity less amount committed or reserved for a specific use gives available balance of the part or assembly for each date on which activity is scheduled. This available balance is the first of the action signals in the Burroughs system. If it is a positive number, it indicates that supply is greater than scheduled demand; the machine automatically flags the responsible planner, so that he may cut back on orders. By the same token, if available balance is a minus quantity, it shows that needs already

anticipated require more components than are available. In this case the computer automatically issues an Action Requisition Notice or reorder.

The Action Requisition Notice and a complete printout of the part record go to the responsible Production Planner. The card supplied also indicates whether Burroughs is to make the part itself or is to buy it and shows by date sequence the quantities of the part needed for every scheduled use, so that the planner knows where and when they will be needed.

Safeguards

There are several built-in safeguards in the program. When reorder quantity—the negative available balance figure—is very small in comparison to the quantity reserved for future production, the Action Requisition card is held up until a general reorder switch is triggered. Also, if the manufacturing date sequence shows that the reorder quantity will not be necessary until some time after the next scheduled general reorder, the signal to the planner is held up. Small items, such as production supplies, use an economic order quantity figure rather than the exact figure required to allow the most efficient ordering of relatively inexpensive items.

When the Production Planner checks the quantities of supplies required and delivery dates desired on the Action Requisition card he sends a signal to the computer via data collection equipment that the action requisition has been converted to a purchase requisition. The original action requisition, with the Production Planner's quantities and delivery dates added, then goes to the Purchasing Buyer, who makes arrangements with the supplier. When these are completed, he in turn returns the Action Requisition card to the computer. There the information both he and the planner have entered—order number, quantities and dates desired, vendor code, and unit price—are keypunched for entry to the computer. There the fresh information updates the inventory file to reflect the new purchase order status.

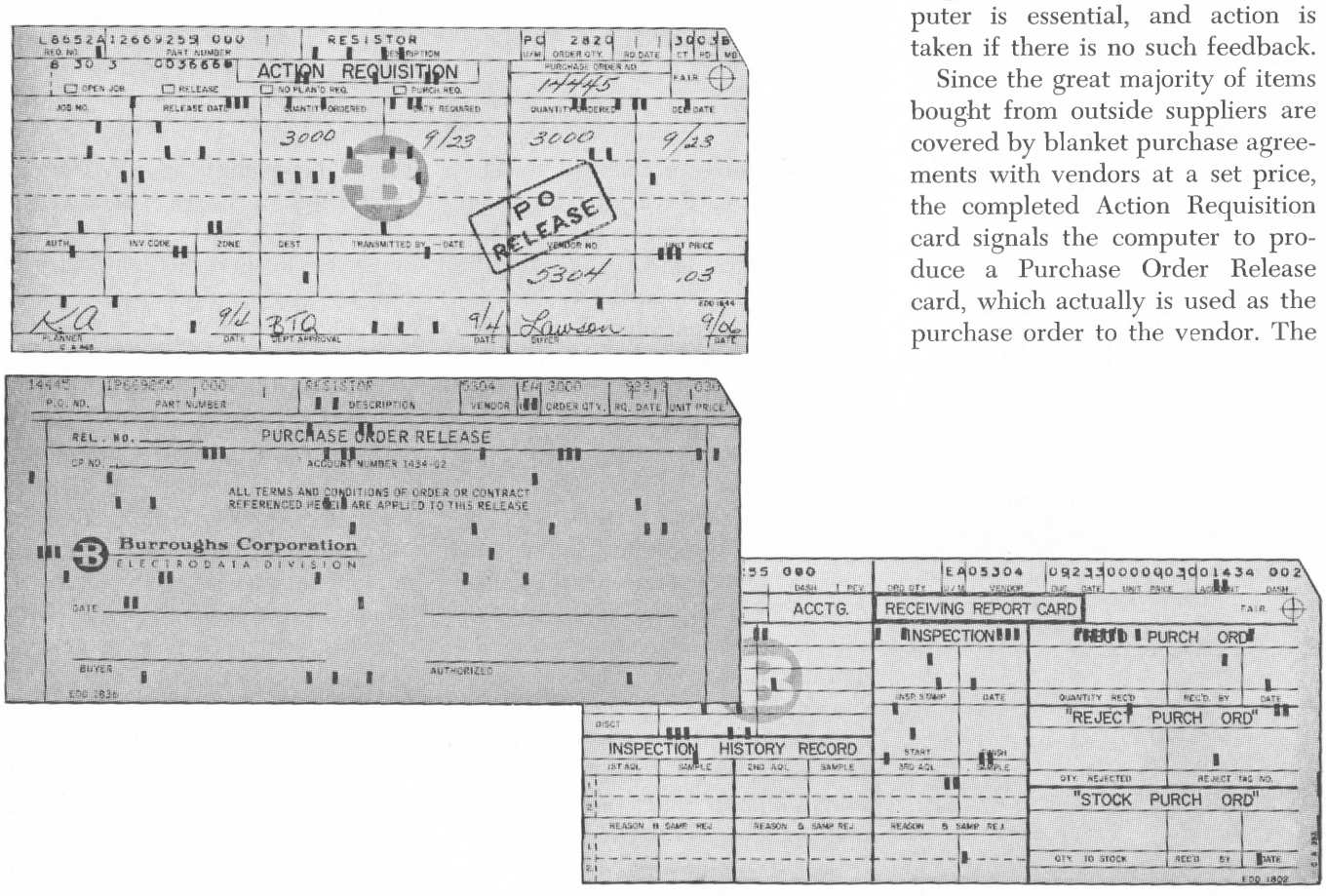
If either planner or buyer fails to return the completed Action Requisition card within seven working days of receipt the computer prints out a second action message as a reminder.

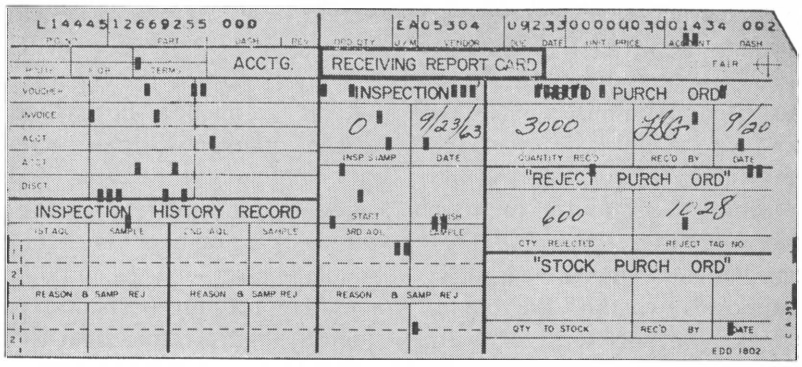
Closed loop

Thus, the Action Requisition is another "turn around" document, a traveling paper that stimulates human action from planner and buyer and generates an automatic reaction from the computer if the desired response is not made within definite time limits. It is a closed loop in which feedback to the computer is essential, and action is taken if there is no such feedback.

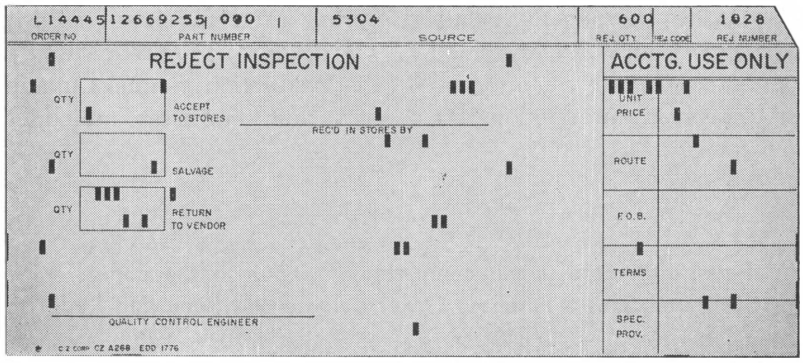
Since the great majority of items bought from outside suppliers are covered by blanket purchase agreements with vendors at a set price, the completed Action Requisition card signals the computer to produce a Purchase Order Release card, which actually is used as the purchase order to the vendor. The

Action Requisition card, when completed, is input to the computer, which automatically prepares a Purchase Order Release and Receiving Report card.





Receiving Report card travels with items received through Inspection and Stores (above). If any portion is rejected, computer produces Reject Inspection card (below).



As each part of a cycle is completed and recorded in the computer files, the data processor automatically produces the action documents needed to inaugurate the next step in the production process.

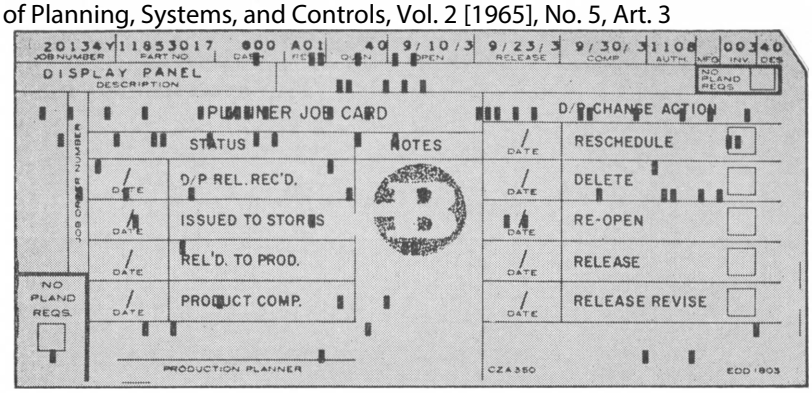
computer also produces a Receiving Report card carrying the same information carried on the purchase order. This is sent to Receiving to prepare that department for receipt of the order on the scheduled delivery date. These three cards are shown in the illustrations on the preceding page.

When the parts are received, a similar system begins to operate to follow the physical movement of the parts, through inspection and rework or rejection. As the shipment comes in, Receiving notifies the computer immediately of the quantity received. This is done simply by inserting the Receiving Report card in the data collection device. There the part identification number and the purchase number are automatically read from the prepunched holes in the card. The quantity received is entered through the dials of the data collector and transmitted to the computer to give the full information required to update the inventory file.

The Receiving Report card prepared simultaneously with completion of the purchase order now is used for the same purposes the Action Requisition card was in creation of the purchase order. Receiving enters quantity received and date on the Receiving Report card, which then travels with the parts into Inspection. Inspection notifies the computer, again by simply dialing the information on a data collection transmitter, of any quantity rejected. The acceptable quantity travels with the card into Stores, which again verifies the quantity of parts or materials received. Stores

then transmits via the data collection transmitter the quantity accepted. Then the completed Receiving Report card, with all the information generated in movement of the goods through Receiving, Inspection, and Stores, goes to Accounts Payable, where it is used as the supporting document for payment of invoices.

Thus, the Burroughs ACTION system has elements of the simplest principle of integrated data processing—entering all information in a form that will permit it to be used subsequently without any need for manual recopying—and elements of the most sophisticated: real time entry into the computer of every significant transaction in the inventory-purchasing-production cycle as it occurs, so that all files in the machine are always current.



Planner Job card is master record controlling assembly of all needed materials until job moves into Production.

Reject cycle

Its final arrival in Accounts Payable ends the life cycle of the Receiving Report card. But if any of the parts received have been rejected for any reason, that sets up another computer cycle. The machine, when it receives a rejection notice input from Inspection, automatically prepares a Reject Inspection card. This goes to the Quality Control Engineer, who decides whether the fault lies with Burroughs because of some accident after the goods were received or whether the flaw is the vendor's responsibility. If the former, the parts are sent to Salvage, to be reworked if possible; if the latter, the merchandise is returned to the seller.

A Salvage Disposition card is created by the computer whenever the choice is made to attempt to salvage some of the rejected goods. The card is sent to the Salvage Engineer and he enters his decision as to whether the parts can be reworked or must be scrapped.

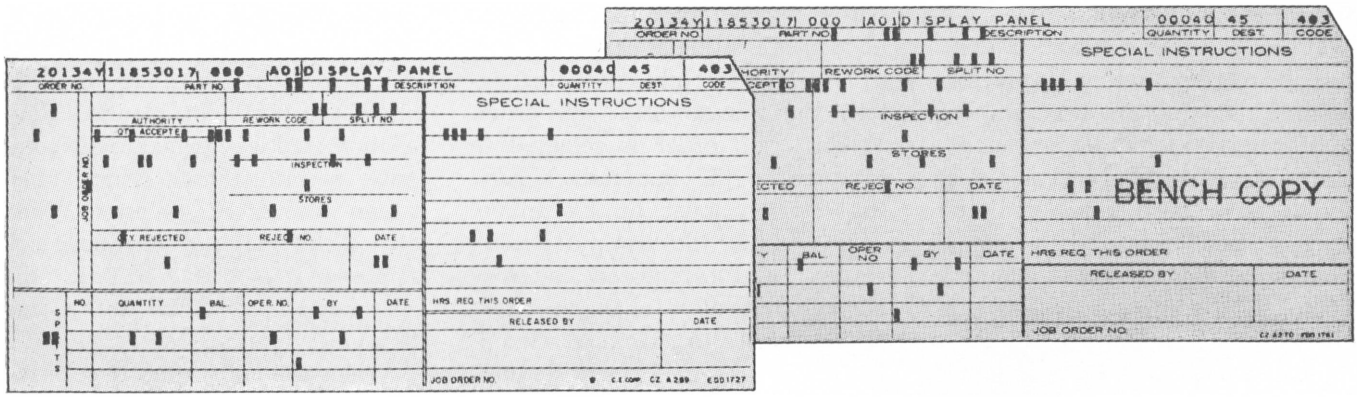
Delinquent notices are prepared automatically by the computer for both the Quality Control Engineer and the Salvage Engineer if they have not returned, respectively, the completed Reject Inspection card and Salvage Disposition card within three days.

The Quality Control Report is also recorded in the inventory file and printed out as either Vendor Replace or Vendor Credit when the merchandise is returned.

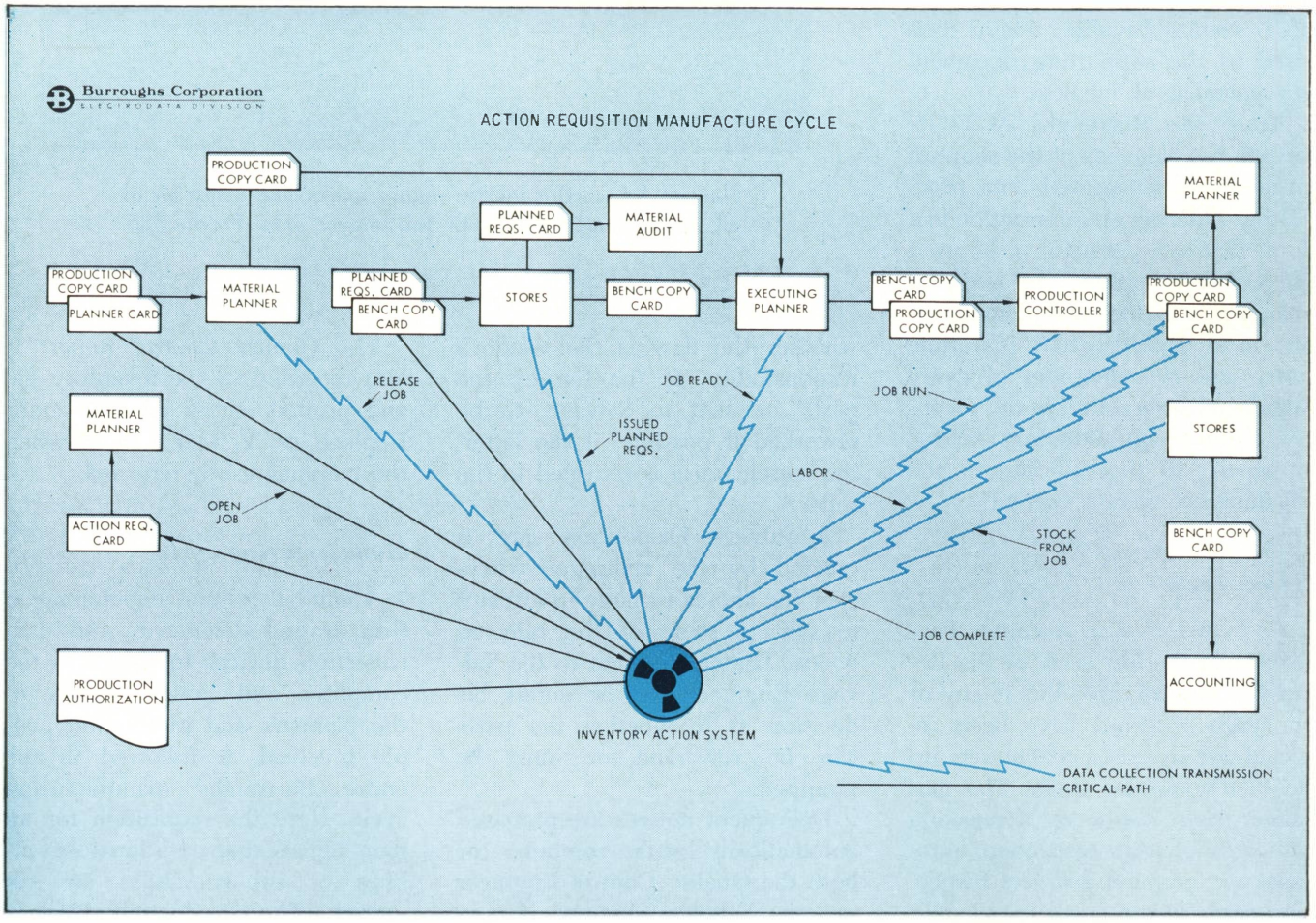
Manufacturing cycle

A similar system, depending on turn around documents and data collection devices for input to the computer and action signals to the planners and production people involved, is followed in the entire Burroughs manufacturing cycle. Here the requisition for an item signals that additional assemblies or sub-assemblies are required. The Production Planner uses the card to submit the input job-opening transaction. The open job is exploded through the parts list file to determine material re-

When job order is released to Production, Production Control and Bench copies of job order are produced by data processor.



The system also has provision for errors. The computer



Above diagram illustrates entire Inventory-Production system developed by Burroughs.

quirements, and reservations are automatically established in the inventory file for each of the component materials required.

When a job is opened, a Planner Job card is automatically created. This job card becomes the master record controlling the entire job until all necessary materials have been assembled and sent to Production and the actual manufacturing process is about to begin. If there is an engineering change or a change in completion date, the new date or new specifications are simply written in red on the Planner Job card and keyed into the computer. All the files within the computer affected by the change are automatically updated.

The Planner Job card also signals the release of a job order. When a job order is released to Production, the materials needed for the job must be assembled. Thus, within the computer each reservation for required materials is automatically changed from "Reservation" to "Planned Requisition" status. A Planned Requisition card is also prepared for each item to be pulled for the job order. Simultaneously, an extended bill of materials, the Parts Order, is prepared. This lists all of the planned requisitions. As each is filled, the pertinent Planned Requisition card is returned to the computer to bring Stock Issue Transaction records up to date. When all of the material has been assembled, it is delivered, with the completed Parts Order, to Production Operations.

When the job order is released

is programed to try to anticipate trouble before it occurs . . . .

to Production Operations, a pair of Job Order cards is produced, one for Production Control, the other as a Bench Copy. The Production Control copy is sent to the Production Zone Controller as his record of the jobs in process in his zone. The Bench Copy accompanies the work as it moves through Production and serves as the master document throughout the production cycle.

From Production the finished product moves through very much the same inspection and acceptance routine that holds true for items purchased on the outside. Again turn around documents and constant revision of computer records give the company close and continuous supervision on the progress of every job and every order.

Some thirty punched card action documents are generated by the system in a constant chain. Each has the job order number or the purchase order number and the part number prerecorded on the punched card so that chances of human error in transcription are minimized.

Exception reports

But the system also has provisions for errors. The computer is programed to try to anticipate trouble before it occurs and notify the responsible parties through a series of exception reports. The computer, by balancing its inventory totals and delivery date against job orders, can immediately flag potential trouble spots.

It does this through a series of action messages. The first is a "reschedule condition." If the planner has enough parts or material on order but their delivery date does not precede the date they will be needed in the plant, the planner is notified through a "Reschedule" message. The planner then has the option of accelerating the supply schedule or delaying the job order if either can be done. The next message, if it is needed, is a Potential Shortage signal. Fourteen days before the reservation due date, the computer scans the part record to determine if inventory levels now are high enough to meet the reservation requirement. If the parts needed are still not in Stores available for immediate use, the Potential Shortage message goes to the planner.

If all this fails and the reservation due date arrives without enough in inventory to meet requirements, a "Stock-out" message is prepared by the computer and sent to the planner. Since buyers receive copies of each of these planner's reports, it's very uncommon for the stock-out condition to be reached.

Advantages

There are several key characteristics of the Burroughs system. First, all action messages produced by the computer are in simple business English. There are no codes. Uniform terminology is used in every phase of the cycle. Thus, every person who must work with the documents understands them. All possible exception conditions produce delinquency reports automatically and the delinquency, if not corrected, automatically produces a follow-up notice which goes directly to the person responsible, and to his superior in the form of weekly management summaries covering each planner and buyer.

Results

Results of the system to date:
Buying has increased five times, but clerical staff is at a lower level than it was before the system was developed.

Production has increased 500 per cent since the system's inauguration, but inventory levels are 25 per cent lower.

Nearly two million dollars a year is being saved on "buy" items since the majority of them are now purchased under blanket contracts.

Anyone concerned can get immediate information about the status of any part, product, or order by direct communication with the central computer, where files are constantly updated.

All accounting records are integrated with the management control system to provide a total management information system. Management has constantly updated, accurate records of the vital information to more effectively control operations. The following are a few of the many facts that are always at management's fingertips:

1. Total inventory value
2. Total purchase commitments (by scheduled dates)
3. Total production schedule
4. Total demand on factory (by scheduled dates)
5. Total exception conditions:
   a. Stock-outs by Production Planner
   b. Production delays by Production Planner
   c. Late deliveries on purchase items by buyer
   d. All expense variations beyond an allowable limit
   e. All delinquent actions by individual and department.

This management information is described by Burroughs' general manager and division directors as having value that far outweighs the total savings achieved with the operating information portions of the system.