INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications	Order-to-Delivery Integration of Manufacturing Operations
Type of Industry	Machine Tool Manufacturer
Name of User	Pratt & Whitney Co., Inc. West Hartford, Conn.

Equipment Used	IBM 1410 Tape/Ramac Data Processing System IBM 870 Document Writing System (3 units) IBM 1001 Data Transmission Units (10 units)

Synopsis

Use of an IBM 1410 tape/Ramac computer and progressive adaptation of the IBM management operating system (MOS) are the means on which Pratt & Whitney Co., West Hartford, Conn., relies to integrate its manufacturing operations as an organic whole, and speed up shipments to customers. This effort was first initiated in 1960 and is now well under way.

All incoming orders for any of the firm's 70,000 stock items result in the automatic production of shipping papers, invoices and two punched cards, one for inventory processing, and a second for invoicing and sales analysis. The inventory card is introduced in the 1410 computer to update stock information. As a by-product of this process, work or purchase orders are produced if items affected fall below reorder point. Completion of a work order is computer-determined and produces updated cost figures.

The MOS concept, based on the integration and control of basic manufacturing functions, has been adapted to permit the automatic updating of economic order quantities (EOQ) and reorder points. EOQ's must be constantly changed to accomodate the addition of new distributors, and insure that their particular requirements can be met. Inventory usage and short-range sales forecasts are produced thereby, providing useful planning tools.

New and valuable management reports that have been developed through the system include: weekly shortage reports; weekly shortage prevention analyses, to indicate which items are in short supply; simulation studies for production and financial planning; profit return reports for top management; monthly inventory analysis. Management is thus enabled to determine the lowest inventory levels required to meet current needs.

In the future, Pratt & Whitney intends to apply the MOS concept to the remainder of its functions, thus achieving an integrated operation sensitive to both customer and management requirements.

Automation is the guiding management concept at the Pratt & Whitney Co., Inc., West Hartford, Conn., itself a leading manufacturer of industrial automation equipment. To maintain and further develop its procedures for total integration of company operations, the company presently operates an IBM 1410 tape/Ramac computer and relies on the IBM management operating system (MOS). First adopted in 1960, this system is now partially in operation, and further advances are expected as its implementation progresses.

Founded in 1859, Pratt & Whitney's roots go back into New England's early industrial history as a Civil War arsenal. Now a subsidiary of Fairbanks Whitney Corp., the firm has 3,000 employes, many of them highly skilled technicians.

Pratt & Whitney products include broad lines of machine tools, cutting tools, and gages. These include both manual, tracer, and numerically controlled machines such as automatic continuous-path milling machines, automatic turret lathes, jig borers, precision rotary tables, and drilling machines; in addition to a complete line of instrument gage, conventional gages and cutting tools. New and diversified product lines include a concrete block manufacturing system.

EDP at Pratt & Whitney

As part of an over-all modernization program throughout the parent corporation, Pratt & Whitney established for the first time, early in 1960, a distributor sales organization for cutting tools and conventional gages. This, coupled with an overall marketing program, resulted in a substantial growth in sales and made it imperative that the firm's Sales Order, Inventory Control and Production Control departments be prepared for the rapid increases and changes in types of orders to follow.

As there was no way of relating the new distributor program to previous sales performance, it was recognized that an inventory system was required which would be immediately responsive to changing requirements and flexible enough to permit management to make policy changes as needed. This led to the abandonment of the manual methods, supplemented by conventional tabulating equipment, previously used for manufacturing control. Studies made in conjunction with Rath and Strong consultants led to the installation of an IBM 305 RAMAC computer in June, 1960, and the adoption of techniques contained in IBM's Management Operating System (MOS).

In January, 1963, the 305 Ramac was replaced by an IBM 1410 tape/Ramac data processing system with 20,000 positions of alphanumeric core storage. The 1410's random access Ramac disc units contain complete information on an inventory of 70,000 items -- 35,000 machine tool components, 10,000 cutting tool items, 10,000 conventional gage items, 5,000 instrument gages, 5,000 raw material items, and 5,000 miscellaneous small tools. The system is also extensively used for scientific computing and preparation of control tapes for numerical control machines. Its operation is the direct concern of nine of the Data Processing Dept.'s 36 employees. They include a programing supervisor, four programers and computer systems analysts, and four computer operators. In keeping with Pratt & Whitney policy, they were selected in-house whenever possible, and were trained by the system manufacturer.

All of the inventory data on items in Ramac are available at a remote printing station located in the Sales Dept. At any time, regardless of the program then being processed by the computer, sales personnel can use this remote station to receive latest inventory and price information from the system, in response to customer requests, without disrupting or delaying normal computer processing. A second remote station is located in the Inventory Control Dept.

In addition, Pratt & Whitney also does general accounting and miscellaneous tabulating work, on the IBM 1410 Computer.

Processing Sales Orders

Incoming orders for any of Pratt & Whitney's 70,000 stock items serve as input for an IBM 870 document writing system which types the order, shipping papers, and invoice and, simultaneously punches a card for inventory processing, and a second one for invoicing and sales analysis. The order and shipping papers are also reproduced on another 870 system in the Shipping Dept. Order data may be mailed in or be transmitted directly over any of the ten IBM 1001 data transmission units located at field sales offices and key distributors. The cards automatically punched at the 1001 receiving station provide input for the 870.

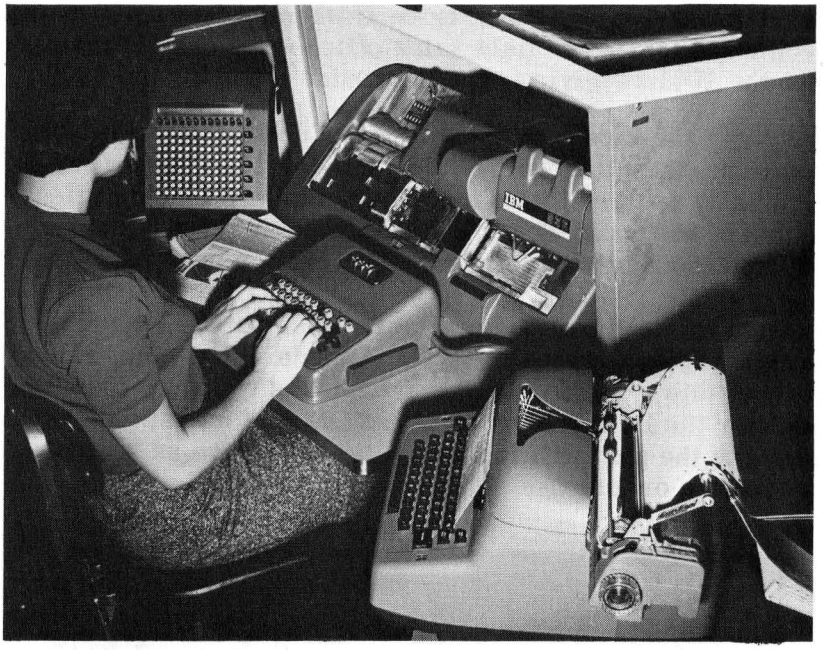
In Data Processing, the inventory card is introduced into the 1410 computer to update relevant stock information. Simultaneously, the 1410 develops costs figures for the Accounting Dept., including perpetually updated totals for each inventory account affected. Other figures produced as by-products of the updating run include the last activity date for each item on the order, usage figures, and the number of orders received for each part.

If one of the items ordered falls below the reorder point, a work order or a purchase request is produced, depending on whether the item is made in the plant or bought on the outside. In a typical transaction of this type, the 1410 may undertake up to four operations, checking first to determine whether the item has fallen below the minimum point, whether semi-finished shelf stock needed to make the part will fall below the minimum as a result, and, if so, exactly how much material should be ordered.

10 IBM 1001 DATA TRANSMISSION UNITS connected to a coast-to-coast private wire network provide punched card order input data.

In producing a work order, the computer is programed to assign a required date for completion; produce raw material and stock issue tickets; indicate whether production should be put on an urgent or rush basis; and provide the means for an open order file which is used for mechanical follow-up. As information flows back to the Data Processing Dept., showing that semi-finished and raw materials have been expended, this data is accumulated in a work-in-process file on the computer. When the work order has been filled and the expended stock replaced, the latest cost figures for the particular item are computed and stored by the 1410. Among other applications, this data will later serve to produce cost variance reports.

A separate program handles manufacturing orders for customers. In one pass, the 1410 explodes bills of material to develop detailed parts requirements which are time-phased or put in sequence, according to the date when the part or raw material will be needed to complete the assembly of which it is a component. The computer than reserves parts or material in inventory on the basis of dates on which needed, automatically producing any necessary reorder documents.



IBM 870 DOCUMENT WRITING SYSTEMS type orders, shipping papers, and invoices; and, simultaneously punch cards for inventory processing and invoicing and sales analysis.

MOS Concept

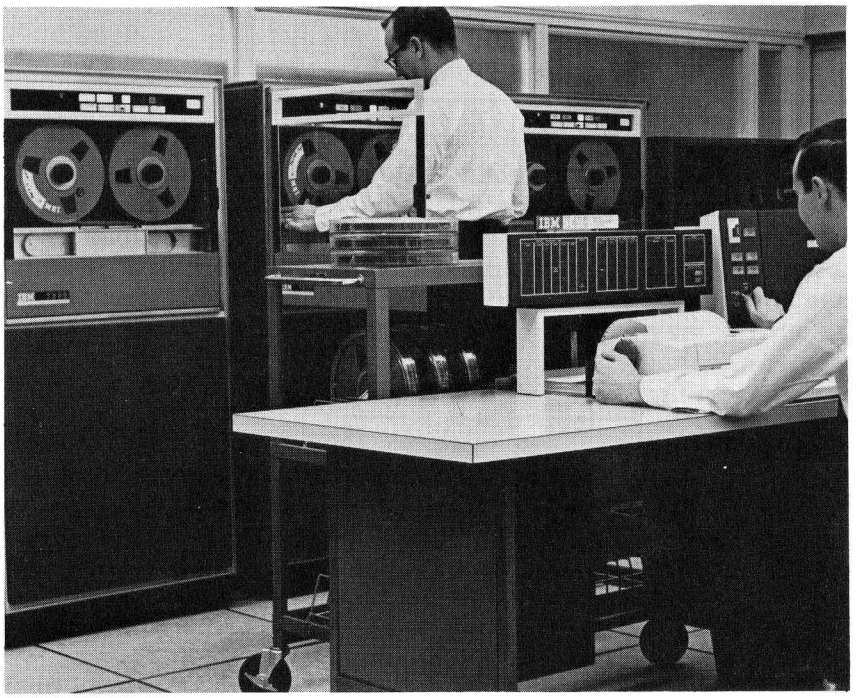
The IBM management operating system is based on the integration and control of six major functions basic to all industrial plants:

Forecasting	Scheduling
Materials Planning	Dispatching
Inventory Management	Operation Evaluation

Through this system, the operations of a manufacturing company are considered as a single integrated whole, where the effect of any one function must take into account its effect on all other functions. The output of one functional area thus becomes the input to the next, reflecting the integration of the system.

A basic decision cycle underlies MOS in action. Certain factors and data representing the "existing plan" (sales history, bills of material, etc.) are stored in the system. New plans and exceptions are generated to be reviewed by management, modified if necessary, and fed back into the system to amend the existing plan. The system is designed to facilitate the entry of engineering changes at the most economic point. At the same time, operating data (orders, shipments, inventory transactions, labor tickets, and so forth) are flowing into the system to update the existing plan. This decision cycle operates continuously throughout the six functional areas.

In its ultimate form, MOS is designed to control the planned production cycle from start to finish without human intervention -- except management decision changes.



IBM 1410 TAPE/RAMAC DATA PROCESSING SYSTEM is used by Pratt & Whitney to implement the MOS (Management Operating System) concept.

Automated Updating Techniques

In its effort to apply the entire MOS concept to its manufacturing operations, Pratt & Whitney has developed a refinement which has already taken it well in the way towards an effective total system. This is the automatic updating of economic order quantities (EOQ) and reorder points, using the 1410 computer.

Usage is the variable common to both of these factors, and the one most subject to change. Pratt & Whitney employs exponential smoothing techniques similar to those outlined in the MOS to calculate a projected usage for use in updating EOQ and reorder point. The exponential smoothing formulae in use provide a moving average which is adjusted for trend. This technique permits calculations to be performed with minimum demands on computer time and capacity. The most active items are updated monthly, others every three or six months, and the least active parts once a year, thus providing reasonable statistical assurance of validity before revising usage data. This automatic computer operation provides great speed and sensitivity in keeping up with changing sales trends.

DATE: AUGUST 10, 1962

SUBJECT: SAMPLE TOOL ORDERS - PREDICTED VS. ACTUAL

THE FOLLOWING IS A SUMMARY OF PREDICTED VS. ACTUAL WORK ORDERS AND PURCHASE ORDERS FOR THE MONTHS OF JUNE AND JULY AND PREDICTION FOR AUGUST, WITH [redacted] ADJUSTMENTS BEING MADE FOR A VACATION TIME DECREASE IN SALES.

	JUNE PREDICTED ORDERS	JUNE ACTUAL ORDERS	JULY PREDICTED ORDERS	JULY ACTUAL ORDERS	JULY USAGE	AUGUST PREDICTED ORDERS
SAMPLE 1	$ 38.5M	$ 30.0	$ 49.8	$ 33.8	$ 44.0	$ 25.1
SAMPLE 2	2.2	1.9	8.9	7.1	9.6	5.9
SAMPLE 3	16.2	11.4	15.7	13.4	26.0	9.6
SAMPLE 4	6.4	8.7	13.3	11.6	13.8	9.5
SAMPLE 5	56.8	75.0	45.5	45.2	32.5	16.1
SAMPLE 6	27.0	23.3	23.7	20.6	23.7	11.1
TOTAL	$147.1M	$150.3	$156.9	$131.8	$149.6	$ 77.3#
		$ 29.5	$ 28.0	$ 33.8	$ 27.5	$ 14.1

SALES FORECASTS

are based on projected usage.

On the basis of immediate past trends, sales forecasts are developed which enable management to predict which work orders should be released in the coming month and to compute the dollar value of projected orders to estimate cash flow. This is done by representing projected usage as customer orders to determine what the production and inventory requirements would be under these anticipated demand conditions. The information developed gives production an indication of what it may expect in a given period so that plans can be made for manpower and other requirements.

REVISED SHORTAGE ANALYSIS - CUTTING TOOL W/E 10/5/62

CLASS	PART W. SHORTAGE	REPEAT SHORTAGE	TOTAL SHORTAGE	TOTAL ITEMS PROCESSED	% SHORT
SUMMARY TOTALS ALL PRODUCTS					
1	51	60	111	2872	3.9%
3	35	5	40	697	5.7%
6	18	4	22	322	6.8%
12	35	4	39	239	16.3%
0	13		13	95	13.7%
GRAND TOTAL	152	73	225	4225	5.3%

SHORTAGES TO BE FILLED FROM

ORDERS IN PROCESS	132		
NEW MFG. ORDERS	55		
NEW PURCH. ORDERS	8		
ON HAND BUT RESERVED	30		
ADJ. TOT.		195	4225	4.6%

WEEKLY SHORTAGE REPORTS

provide Pratt & Whitney management

with improved inventory controls.

Management Control Reports

New and valuable management reports have been constantly developed through implementation of Pratt & Whitney's scientific management program:

1. Weekly shortage reports detail which items have been back-ordered, how often the particular item has been short, and the percentage of over-all item shortage against incoming orders.

2. Weekly shortage prevention analyses indicate which items are in short supply. These are qualified by an urgency factor to highlight them and show which should be expedited.

3. When the Sales Dept. provides long-range forecasts, simulation studies are conducted to aid in production and financial planning. These supplement the short-range forecasts which are a regular part of IBM 1410 production.

4. On demand from top managements, studies are made of profit returns for product type, usage, class, etc. These indicate which items are moving slowly, which are active, and the profit derived from each.

5. A monthly inventory analysis measures stock performance versus finished parts and work-in-process inventories. These figures show whether the firm's over-all inventory policy is functioning as it should, and whether it should be altered to allow for a greater or lesser quantity of inventory actually on hand and in pipeline. They are of great value in keeping up with sales trend, particularly where the distributor system is concerned.

6. Daily sales report by product type.

Top management has thus been provided with the means to change inventory policy quickly, when needed. If it wishes to consider trimming inventory levels and lowering safety stock margins, the Data Processing Dept. can swiftly indicate just what the effects of this change would be. The analysis is delienated category by category, and also shows the effect the policy change would have on both finished stores and work-in-process inventories.

RAMAD	PART #	DESCRIPTION	WO QTY	WO #	WO REQ DATE	DAYS SUPPLY	LEAD TIME
100498	234 615 000	5/32 DR HS SS T	35	1A1265	680	27	50
101064	262 617 000	9 DR HS JOB LG	336	1A1349	680	31	50
101016	220 617 000	29 DR HS JOB LG	858	1A1369	680	36	50
100744	223 616 000	9/64 DR HS SCR	464	1A1433	660	6	27
100286	420 612 000	27/32 DR HS 2 M	18	1A1461	673	13	35
102272	402 650 000	11/16 SLUR DMNG	66	1A1473	691	18	50
100006	223 611 000	9/64 DR HS 1 MT	38	1A1483	678	5	35
100034	350 611 000	23/64 DR HS 1 M	42	1A1494	678	19	35
100112	435 611 000	31/32 DR HS 3 M	12	1A1505	679	13	35
100604	437 615 000	63/64 DR HS SS	5	1A1539	684	20	35

ITEMS IN LOW SUPPLY REPORTS indicate urgency of items to be expedited.

In one typical situation, management was presented with simulated results relating to inventory policy changes for certain categories of items on which there appeared to be no need to maintain the stock levels and work-in-process activity then prevailing. Management studied three simulated alternatives and then made a choice based on scientific factors, not guesswork. New EOQs and reorder points were computer-developed within 24 hours to reflect the new policy. Pratt & Whitney can thus manipulate inventory under rigid controls, and according to scientific principles which afford maximum protection against stock-outs without major increases in inventories.

Results and Future Plans

Pratt & Whitney has derived many benefits from its present program since its inception in 1960. They range from better customer service through reduced manufacturing costs. Paperwork lead time has been reduced and plans are underway to cut it still further. Since the 1410 computer indicates priorities on the work orders produced, scheduling in the shop has improved. Stock-outs have been lowered through the shortage prevention reports which show relative urgency of current shop orders.

SUGGESTED DISTRIBUTOR STOCKING LIST

RAMAD	PART NO	DESCRIPTION	PC	QTY	N1	UNIT PR	EXT COST	ORIG QTY	MIN	CC
117064	0018-719-000	1/16 C O BLADE	0	11	667.6	.61	6.71	11	1	
117066	0022-719-000	5/64 C O BLADE	0	3	157.5	.57	1.71	3	1	
117068	0026-719-000	3/32 C O BLADE	0	16	930.9	.72	11.52	16	1	
117070	0034-719-000	1/16 C O BLADE	0	3	149.1	.40	1.20	3	1	
117072	0038-719-000	3/32 C O BLADE	0	12	731.9	.92	11.04	12	1	
117074	0042-719-000	1/8 C O BLADE J	0	13	777.6	.88	11.44	13	1	
117076	0046-719-000	5/32 C O BLADE	0	2	105.7	1.03	2.06	2	1	
117078	0050-719-000	3/16 C O BLADE	0	4	244.1	1.03	4.12	4	1	
117082	0058-719-000	3/32 C O BLADE	0	1	66.6	1.24	1.24	1	1	
117084	0062-719-000	1/8 C O BLADE J	0	4	212.5	1.49	5.96	4	1	
117086	0066-719-000	5/32 C O BLADE	0	1	84.1	1.30	1.30	1	1	
117088	0070-719-000	3/16 C O BLADE	0	4	213.0	.94	3.76	4	1	
117094	0086-719-000	3/16 C O BLADE	0	1	55.0	1.80	1.80	1	1	
				75	4,395.6		63.86	75		13

COMPUTER-PRODUCED REPORTS have made possible better customer service as well as reduced manufacturing costs.

The remote inquiry unit has proved to be of real importance in the area of customer service. The Sales Dept. can now respond rapidly to customer demands on a factual basis to an extent not previously possible. Additional speed will be provided through the gradual expansion of the present coast-to-coast private line network for the IBM 1001 data transmission units. Additional units will be installed at the offices of distributors who desire them.

Because of the increase and changed demands in sales of cutting tools and conventional gages, management has no way of estimating savings in stock levels. It believes, however, that without the current inventory system the stock level would have been considerably higher to handle present sales volume. In addition, the automatic updating of EOQs has resulted in lower product costs.

In the near future, Pratt & Whitney intends to adapt the entire MOS concept to its manufacturing operations. The firm is already well into the areas of forecasting, materials planning, inventory management, and operations evaluation. Even within the remaining areas, scheduling and dispatching, the comprehensive computer program does much to predict shopleads and follow-up shop orders on an exception basis. As the integrated manufacturing system is further implemented, it is hoped to achieve an even more effective operation sensitive to both customer and top management requirements.

In the meantime, the firm's immediate objective has been accomplished, and the increase in sales volume stemming from the new marketing program has been consolidated. Without the present system, management does not believe that it would have been possible to keep pace with the new sales pattern for there was no way of relating past history to the new situation, or of keeping up with slow-moving items which became very active almost overnight. A new degree of accuracy and responsiveness to change was essential and has been achieved.