INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications
Production Control, Procurement Control, School Scheduling, Duplicating Services

Type of Industry
Aircraft Manufacturer - Automation Center

Name of User
McDonnell Automation Center, Inc.
St. Louis, Mo.

Equipment Used

IBM 7094 Scientific Computing System	IBM 1301 Model 1 Disc File
IBM 1401 Data Processing Systems	IBM System 360/30 Multiprinter
IBM System/360 Model 30s	IBM 1030 Data Collection Equipment
IBM 1460 Data Processing System	IBM 1405 RAMAC
IBM 7080 Data Processing System	IBM 1050 Data Communication Equipment
IBM 7010 Data Processing System	

Synopsis

The McDonnell Automation Center was established in 1960 as the company's first venture into the commercial field. The Center began with 258 people: there were 78 mathematicians and technicians in the scientific computing group and 180 system analysts, programers and technicians in administrative data processing work. Today, the Automation Center employs 925 persons.

This report concerns itself with administrative applications performed by the Automation Center -- production control, procurement control and school scheduling -- with corporate duplicating services.

Since its founding the Automation Center has served a wide variety of industries and has provided data processing services, consulting, systems analysis and programing services.

The Center also performs a variety of scientific applications and uses a number of scientific computers for this purpose which are not listed in this report. These are both analog and digital, major hybrid installations. In addition, demand deposit accounting is done for a number of banks in St. Louis and Denver.

Some of the scientific applications performed by the Center are Mathematical Programing, Reliability Studies, Numerical Control Computing, Test Data Reduction, among many others. Administrative applications include, among others, Statistical Analysis, Advertising Research, Mortgage Loan and Savings Accounting and Personnel File Maintenance.

Class scheduling, grade reporting and/or transportation and attendance reporting was performed for over 160,000 students in approximately 100 schools in eight states during the 1964-65 school year.

In addition to performing services for clients, the Automation Center processes payroll and labor costs for the parent company. It schedules, releases, follows up and determines the parts requirements for more than 60,000 production work orders each day. If need be, it can reschedule all the parts required to build a complex aircraft in about 30 minutes, a job that involves about 250,000 parts and assemblies.

The McDonnell Automation Center operates $25 million worth of equipment, including 30 digital and 19 analog computers in St. Louis and Colombia, Mo.; Houston, Tex., and Denver, Colo.

DELCOS, Inc., in Denver, became a part of the Automation Center in 1963 and provides data processing services to banks, school districts, utilities, manufacturers, retailers, government agencies and others in the Rocky Mountain area.

In Houston, the McDonnell Automation Center of Texas provides similar services and various scientific applications to industries in the Southwest.

The McDonnell Automation Center, Inc., Colombia, Mo., provides keypunching service for the Automation Center and its clients.

Some of the more complex commercial assignments include development of an on-line inventory control system for a frozen food distributor; design of a complete operating system for a major refinery, including simulated operation of the plant; market forecasting and linear programing for one of the largest chemical companies in the world; design of a production control system, covering inventory, sales and distribution, for a large brewery, and class scheduling and grade reporting for schools and colleges.

One of the largest files contains data on 20 million names and addresses, which represent the complete mailing lists for a number of users.
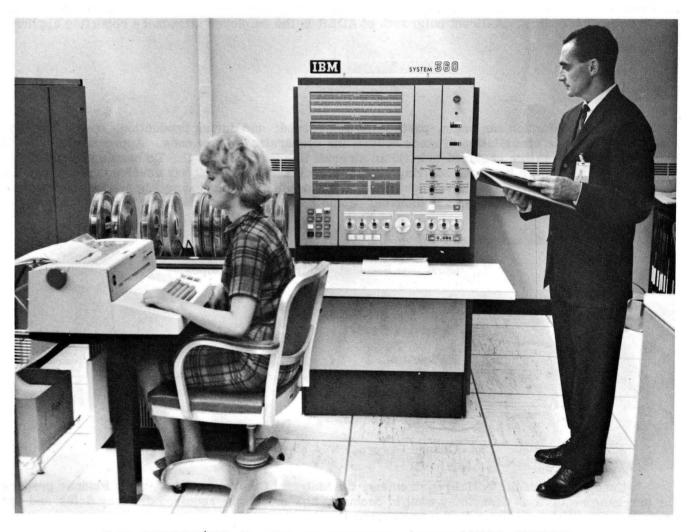
THE SYSTEM

Production Control

One of the largest on-line data collection systems in the United States is in operation throughout the parent McDonnell Aircraft Co. in St. Louis. It uses IBM badge/card readers, with a capability for inputting variable data, linked to central processing equipment in the Automation Center.

The readers are located at employe entry and exit points and throughout the manufacturing area to record starting and departure times. Each work order in the plant is accompanied by a job control punched card. As each stage of the total job is completed, the punched card and the production worker's code-carrying badge are inserted into a reader. This worker-job status is transmitted to the computer where all information on the normal flow of 80,000 to 100,000 production orders is stored. Exceptions to planned goals are automatically detected and exception reports printed out for management attention.

Information from the plant data collection system can also be used to prepare other reports, such as analyses of construction time required for various elements of an aircraft or spacecraft, or job performance studies.

The scheduling, release, and updating of requirements for production parts can be run on a daily basis. If necessary, schedules for 50,000 to 100,000 parts can be revised completely in

IBM SYSTEM/360 AT THE McDONNELL AUTOMATION CENTER

approximately 30 minutes. This rescheduling would involve approximately 250,000 parts and assemblies. A by-product of this program includes a report prepared daily which shows the status only of those critical parts which have not net scheduled dates. This is true management by exception.

Using information collected through these systems, one program presently updates a 300-character record for each of 39,000 employes weekly and includes changes in personnel data, rates, deductions, and updated records of earnings and taxes.

A major consideration in these systems -- Manufacturing Control and Procurement -- is data collection. An Automation Center developed application of data collection is used to follow approximately 70,000 work orders through a shop. The status of each work order, its present location, and phases completed, is constantly known. From special variable data collected from remote transmitting stations, the computer prepares various special exception reports. The computer processes collected data against open order files and develops priority work lists, completed order inventories, work lists for overtime jobs, and material shortage notices. Additional computer output is a visual record, designed to be transfer posted, of every in-process work order. Tied directly in with the automated work order control system is Automated Direct Labor Hours Reporting (ADLR). ADLR, an Automation Center developed system, utilizes data collection methods to report direct labor hours against open job orders. A direct outgrowth of ADLR is the employer attendance reporting application.

Procurement

Before production can begin, parts must be ordered; and during production, frequent design changes necessitate cancellation of some orders and preparation of new ones. Approximately 250,000 parts and assemblies are required to build an aircraft like the Phantom II. To handle procurement -- from purchase order through receiving report -- McDonnell Aircraft has developed a program that uses a single document, a purchase requisition, from which all other documents needed in procurement, plus management reports, are derived. Some 8,000 purchase orders are handled a month.

The derived documents are:

1. Quotation Request/Addressed Envelopes.

2. Purchase Order.

3. Receiving Report.

4. Follow-up.

5. Forecast Reports.

6. Shortage Reports.

7. Change Orders.

Upon receipt of the initial requirement, the Material Control or Subcontract Planner prepares the purchase requisition describing what to procure, how much, the required delivery dates and any specific instructions pertinent to the procurement.

The buyer, upon receipt of the purchase requisition, adds code numbers for the potential suppliers and other purchasing information. The purchase requisition is forwarded to the Automation Center to be keypunched and then is returned to the buyer pending receipt of the bids.

All bids are evaluated upon receipt and one supplier is selected. The buyer then adds the remaining information to the purchase requisition in order to prepare a purchase order. This information includes the purchase order number, the unit price, and any changes required. After the purchase requisition is approved, it is again submitted to the Automation Center for keypunching the changed or added portions. These cards are then matched against the data previously stored on tape and a purchase order ditto master is generated. Data that pertains to receiving reports, purchase change orders, purchase order follow-up and forecast reports are stored in random access files.

Punched cards, produced from data stored in the computer, are fed into data transmission equipment causing output devices at the proper receiving stations to print receiving reports. After shipment is received and information entered on the reports, cards are punched at the receiving site and the data is transmitted to the computer for updating of the random access file.

The procurement system also produces vendor follow-up notices, projected delivery and shortage reports. As a by-product, it provides automated input to the inventory record system and to accounts payable. Because all pertinent data is stored in random access files, management can obtain almost instantaneously reports on purchase order and delivery status.

There are plans to extend the system and its functions. One planned extension would have the purchase requisition prepared automatically, taking the "parts to be ordered" directly from engineering drawings. This procedure would be combined with another -- used to produce data employed by personnel in the manufacturing areas -- into an Automated Drawing Parts List System. Thus, the procurement and manufacturing orders would be covered by one system, resulting in less document handling and faster processing.

School Scheduling, Grade Reporting, Transportation and Attendance Reporting

The school scheduling program will handle nine tracks, or ability levels. This service is currently being utilized by 63 schools with a total enrollment in excess of 75,000 students. In addition, 33 schools are using the attendance and transportation reporting system, bringing the total students' processing by the Automation Center to over 105,000 for the first half of the 1965-66 school year.

There are three phases to this program:

1. Registration Summary and Conflict Analysis

2. Student Scheduling

3. Grade Reporting

The Registration Summary and Conflict Analysis is a report that shows (a) the total number of students requesting each subject and (b) a cross tally of the number of students requesting any combination of two subjects. It accommodates a maximum number of 350 students. Processed as soon as registration is completed, this report assists the school administrator in developing the master schedule.

The McDonnell General School Scheduling Program was developed for the dual purpose of solving the general problem of student scheduling and meeting as many specific requirements of as many different school systems as possible.

The General School Scheduling Program performs a preliminary analysis in which each student is considered as if he were the first student to be scheduled. The actual total number of workable schedules for that individual student is computed. The students are then arranged in sequence by this number of workable schedules, with the student who has only one possible schedule placed first and the student with the most workable combinations placed last.

This preliminary analysis also performs another service. It identifies those students who have no workable schedules (the absolute conflicts). The school administrator may specify, prior to processing, the maximum allowable number of absolute conflicts and, if this number is exceeded, request that processing be terminated at the end of this phase. A conflict list is then printed out and corrected or amended before proceeding further with scheduling.

Another feature of the General School Scheduling Program is that it can place students into classes according to their ability. This is known as tracking. For example, a given student may be rated over-all as a track 1 student, but his actual ability may vary from subject to subject. He may be a track 1 in mathematics and science but only track 2 in English.

When filling out the input card for the scheduling program, the counselor indicates the track for each subject for that student. Codes are also listed for each subject which instruct the program about track and subject substitution, in the event the initial request can not be met.

Home rooms are scheduled by the program in three ways:

1. By indicating that a home room meets a particular period of the day. Whatever room the student is in during this period becomes his home room.

2. By associating a particular subject with home room. Whatever room the student is in for this subject becomes the home room.

3. By specifying certain teachers. The home room is then based on class year, and on the further requirement that the student must be assigned to the home room teacher for some academic subject also.

In scheduling classes, normally a school will specify the capacity of each room and will not want this capacity to be exceeded. This restriction can be relaxed if it is the only way a student can be scheduled. This is not done, however, except when every other possible combination has been tried and failed.

Grade cards, which consist of one card for each student in each classroom, are arranged alphabetically by student name, by classroom and teacher, and then forwarded to the school. The teacher simply places a mark on the card corresponding to the grade for the student. After the grade cards have been marked, they are returned to the Automation Center where they are processed to generate the grade report; to calculate student averages, both current and cumulative; to select and list all failure and incomplete grades; to tabulate the number of each kind of grade given by teacher and subject, and at semester or year end, to print the final grades on a pressure sensitive label that can be quickly affixed to the permanent record cards.

The school scheduling program has been in operation for over five years and has proved successful for schools as small as 400 students and as large as 2,800 students. It has been used for large metropolitan school districts, such as the city of St. Louis, for the Catholic archdioces of St. Louis, and for other schools in eight different states.
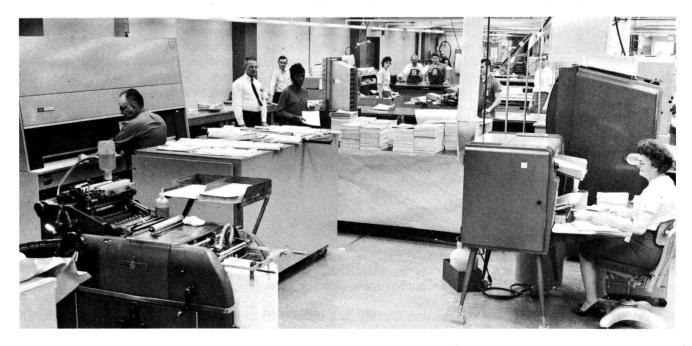
Duplicating Services

Computer-printed information destined for wide distribution, such as the procurement documents and other documents referred to above, is reproduced in the Corporate Duplicating Department. Reproduction of up to 5,600 copies from a computer-printed master is not unusual at McDonnell. For most large copying jobs, however, plates are made by an Itek 11-17 Platemaster from the printed original. Individual jobs may vary from several hundred originals per report to as high as 3,800 originals; the average run is 65 to 90 copies for each original.

Corporate Duplicating comprises five sections. All are under the direction of the company's General Services Department.

Each section performs the same basic tasks of reproducing engineering drawings and various reports, proposals, memos and the like, but each also has certain areas of specialization. For example, most of the brochure printing and reproduction of computer printout is handled in one section; another handles tasks from the offices of the company's top executives.

All drawings must be processed through the department on an expedite basis. The average distribution per drawing is 45, including both external and internal users. Reproduction of drawings in the various corporate duplicate sections total about 2,260,000 square feet per month. The average drawing size is 21 square feet, but the range is extensive: from "A" size -- 8-1/2 by 11 inches, to roll size -- 36 inches by 27 feet.

McDonnell uses three Xerox 1860s to produce either a diazo or offset master with four fixed reductions available. It will accommodate originals up to 36 inches wide and any length.

ONE OF THE CORPORATE DUPLICATING SECTIONS
WHICH HANDLES DOCUMENT REPRODUCTION.

Masters produced by the unit are used on either diazo (Bruning, Ozalid, or Ditto) or offset (Multilith, Davidson or A.B. Dick) equipment to make the required number of copies. Two Marbank machines fold most of the large copies produced by the diazo units, but some of the folding is done manually.

Before the 1860s were installed, a Neo-Flo camera was used to photograph each drawing, then the roll negative was wet-processed, dried and reproduced on a blueprint printer. This tandem, while sufficient for the quality of work required, is slower, and is more costly to operate. It does, however, accommodate wider drawings (up to 42 inches) than the 1860-based system and is used for them.

Before a drawing is reissued in its entirety, five alterations may be made to it. When an engineer makes a change, he photographs with a Polaroid camera the area to be changed, then the alteration. The pictures are mounted on engineering order forms, which also contain written or typed data, then are sent through the reproduction process.

Masters of the engineering order forms, and of other documents small enough to be accommodated by the machine are made on a Xerox 914. There are 41 914s, each with full time operators, at diverse locations throughout the corporate complex. These are used for routine copying jobs requiring less than seven reproductions. Any project exceeding this limit is sent to the nearest corporate duplicating installation.

When originals come into the corporate duplicating department, they are accompanied by a four-part color-coded printing request form. The requestor stipulates on the form what type of reproduction he desires, if he has a preference. As a basic rule, offset is used for 20 copies or more; diazo for less than 20 copies. There are exceptions, such as a short-run job requiring high quality printing.

Both the Air Force and the Navy require microfilm copies within 30 days after drawings relating to their projects are released to production. The 35mm film must be of optimum quality so that it can be used to produce duplicate films or prints.

Internally, film is used solely as storage media and drawings are not photographed until they reach inactive status.

Before photographing an original, with a Keuffel Esser Micromaster, the operator places code numbers on the drawing indicating what size it is, how many frames it will occupy, and the sheet number if the drawings consists of more than one sheet of paper. The same data, plus film index information, is logged by the operator for subsequent conversion to punched cards.

Film is processed on a Remington Rand Unipro, then checked on a Thermofax reader for quality. Identifying punched cards are sent to the Automation Center which produces two duplicate decks; one deck accompanies the roll of film to the customer and the other remains in the microfilm area as a source for verifying that drawings have been filmed. If the film is for internal storage, only one deck of cards is cut.

Results and Future Plans

The functions performed by the McDonnell Automation Center and which are described in this report are only several of a variety of applications. In addition to the administrative applications here described the Automation Center performs a number of scientific applications.

Since its beginning the Automation Center has continued to grow. At present, the Automation Center's staff numbers 925, backed by more than $25 million dollars worth of equipment, of which only a portion is listed with this report.