REAL-TIME MANAGEMENT CONTROL
AT THE
HUGHES AIRCRAFT COMPANY

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Summary

We have reached an impass as data processing professionals unless we use a new approach in meeting management information requirements. Our old approach - such as batch processing, maintenance of voluminous card and tape files, and rigidly structured reports - can no longer do the job. We must continually recognize the implication and impact of the dynamic nature of the industrial environment. New products, more acute competition, shifting skills, changing customers and reduced lead times place staggering demands on operating managers for faster decisions and more accurate answers. In addition, these rapidly changing conditions make it impossible for management to predict, with any preciseness, what future information needs will develop. What they do know - and demand - is that our information systems must provide more visibility and responsiveness. These systems inherently must be more flexible and contain more economy of operation than traditional techniques afford. At the Hughes Aircraft Company, we are meeting these requirements through the growing utilization of source data recording, large random access file processing, and high character-rate tape units. In addition, we make the greatest possible use of programming aids such as automatic coding routines and report generators. Our Finished Goods and Shipping information system exemplifies the use of these tools in our current approach to real-time control.

Management Information Requirements

As noted recently in the Wall Street Journal management disenchantment with data processing has set in - and will continue to spread - unless we recognize our present shortcomings. We must adopt totally new methods - now - to satisfy today's management information requirements. These requirements have been postulated and expounded upon ad nauseam. Yet, by their very nature these requirements will continue to serve as a criteria and a measure of our successes and failures. It does not seem inappropriate, therefore, that we should review them again.

Quality Improvement of Data

One authority defines information as "... knowledge derived from the organization and analysis of data" and data processing as "... the conversion of data into information". Obviously, the value of any information so produced will be a function of the accuracy and timeliness of the data from which it was derived. All too frequently, our old techniques of converting raw data to machine language formats - transmittal preparation, key punching and verifying - have defeated our objective of obtaining current, valid data.

Flow Time Reduction

In the past - and I suspect for sometime into the future - we have been and will be criticized for using our computing power for the sole purpose of producing documented hindsight. Far too great a portion of our data processing reports show where we have been, rather than where we are and where we are going.

Much of this is attributable to batch processing transactions and changes - and our voluminous card and tape files seem to preclude any different approach if economy of operation is to be considered. I think it is fairly obvious that when we batch process for file maintenance and reporting, we are updating files with events that occurred, on the average, one-half the batch-period-interval ago. In short, many of our monthly financial reports reflect important financial transactions that took place 2-1/2 weeks before! This kind of performance will no longer do. If electronic data processing is considered a management science - and I believe it is - our main goal, according to Peter Drucker, "... must be to enable business to take the right risk". "Indeed", he goes on to say, "it must be to enable business to take greater risks - by providing knowledge and understanding - and by measuring results against expectations thereby providing means for early correction of wrong or inadequate decisions". The flow time between data inception and information reporting can be and must be reduced. As one of our managers has put it, he wants visibility, not perspective; information, not history!

Responsiveness and Flexibility

As data processing people, it seems to me that all too frequently we attempt to ignore the dynamic nature of the industrial environment in which we work. Hardly a day goes by when our companies and management do not experience a change in product or a change in competition, a change in customers or a change in regulatory specifications.
The American Management Association puts it this way, "We live in an ever-changing world. Everything about us - and we ourselves - change to a greater or lesser degree. So far as the business situation is concerned, this state of constant flux introduces two very real complications into our calculations. First, we find as we look into the future that the number of possibilities to be considered increases at an astronomical rate. Second, the further ahead we attempt to plan, the greater the uncertainty factor, which also operates to increase the number of alternative decisions we must consider. On the whole, flexibility and adaptability are urgently needed to adjust quickly to shifting conditions." 

In the face of this situation, data processing must become increasingly more responsive to implementing requests for new applications. It is imperative, I think, that we reduce system's design and programming lead time. In this sense, it will always remain incongruous for us to talk, in the same sentence, of machine processing in terms of micro-seconds and programming in terms of months!

As for flexibility, the difficulty and expense of changing report content, format and sequence has made it mandatory for us to establish controls on change requests. Then, as changes increase in volume and frequency, subtly but inexorably, our controls become impediments designed to discourage change. Carried to extremes, our relative inflexibility leads us to creating reports, we find to our utter amazement, that are neither used nor read.

**Hughes Aircraft Company Approach**

**Automatic Data Collection**

At Hughes Aircraft Company, the need to improve the accuracy and timeliness of input data has been recognized as a chronic problem. The multiple operations we required in the preparation of such data by conventional methods permitted the introduction of human error - as well as time delays - at every step. This input gap - between the recording of information at its source and its later processing - has been bridged by the introduction of "Automatic Data Collection" equipment. We are using this equipment currently for:

1. Labor Attendance Recording
2. Labor Distribution Recording
3. Order Location Recording
4. Quality Control Data Recording
5. Inventory Control

In terms of pure economics, the introduction of this equipment reduced clerical costs through the elimination of many handwritten documents; it obviously reduced key punching and verification costs as well as reducing control and audit requirements.

**Large Random Access Files**

The storage of data on numerous decks of punched cards necessitates multiple machine runs, a great deal of lost time in having to pass the same decks through the system many times for such operations as sorting, merging, calculation and listing. On the other hand, magnetic tape creates difficulties in interrogation of information contained in the tape files and would, in cases in which these interrogations had to be answered quickly, require voluminous print-outs or frequent computer interruptions for tape file searches. Our problem, then, was to develop a system that could produce timely working paper and reports - at a price we could afford. The solution we chose was mass random access storage. Subsequently, we installed a dual-processor, 40 million character storage RAMAC system to complement our 705 and 1401 computer systems. For the first time, we have the ability to maintain a number of massive files as frequently as four times per day! Having divorced ourselves from batch-process frequencies, we now generate working documents such as work orders, priority reports and delinquency reports on a meaningful basis.

**Report Generators**

In our efforts, at Hughes Aircraft Company, to increase data processing flexibility and responsiveness, we have and will continue to rely heavily on automatic programming and report generators. In this regard, we have programmed our own report generator, for a tape system 1401, which utilizes control cards specifying format and control total fields, but does not require computer assembly time. Only from extensive use of these "soft-ware" packages can we get the most for our programming dollars - more programs, in less time, with less effort.

**Finished Goods and Shipping Control**

A brief review of an inventory control system in operation at one division of Hughes Aircraft Company can serve to illustrate an integrated application of real-time source data recording, large random access file processing and report generators.

The Finished Goods and Shipping inventories may be said to represent the culmination of the production and supporting departments' efforts. The products in these inventories - such as end
"black boxes", shippable spare subassemblies and modification kits - represent a considerable financial investment. Their anticipated shipment is a major consideration in determining realizable income. Of equal importance, these products must be shipped according to stipulated schedules defined by contractual obligations. It was imperative, therefore, to establish accurate and timely controls. The system in general, then, is one of maintaining a record of all inventory status changes, by part number and serial number, from receipt of the product (from assembly work-in-process) to actual shipment. In addition, the control system has the inherent ability to provide immediate replies to such questions as:

Was the product closed into finished goods in compliance with the manufacturing schedule?

What is the location and condition - test and inspection, rework, shipping, inventory, etc. - of the completed products?

Was the product shipped in compliance to contractual schedules?

Input Transactions. The system, as illustrated in Fig. 1, utilizes three Stromberg Time Transacters to record the movement and status of products. One is located in the Finished Goods Stores, the second in the Product Compliance area, while the third is located in the Shipping Office. Three classes of information are entered and recorded simultaneously - a plastic stub card containing the transaction code, a pre-punched part and order identification card, and variable information such as quantities or DD250 numbers which are entered through the transacter dials. By means of this source data recording, faster input and more accurate recording of transactions to the inventory records is thus accomplished.

File Records. The inventory records are maintained on Ramac disk files in two forms, a part number record and a serial number record for end units. The part number inventory records are fairly typical in that they contain summarized information such as the total quantity in rework or in test and inspection. In addition, cumulative totals are maintained for manufacturing and delivery schedules. The part number record contains, as well, part identification codes (end unit, subassembly, or modification kit) and procurement codes.

The serial number record is unique, however, since it contains the latest information on the location and status of each end unit. In addition to providing supporting details for the quantities in the part number record, its primary function is the provision of replies to the types of inventory questions raised earlier. However, these records would be of little value if we could not maintain or interrogate them on a real-time basis as provided by random access storage.

Output Reports. In addition to supplying interrogation replies, the control system provides management utilizing week-on-week production and shipping performance - what was manufactured and shipped according to the specific, predetermined plan and what variances occurred. Equally important, a delinquency report by making department is supplied. Other reports are and will be provided, as management requires them, without undue delays. Through the use of report generators, we have the ability of dumping the file contents on tape and process them through the 1401 computer for any conceivable type report utilizing the file data. This can be done more quickly and economically than any technique we have used in the past.

Other Applications

Obviously, Hughes Aircraft Company is not the only company to recognize the advantages offered by new hardware and programming aids. A number of companies, large and small, have implemented or are planning similar systems. Faced with a problem of maintaining and controlling 160,000 tab cards utilized in a spare parts inventory management control application, Convair-Astronautics in San Diego turned to large random-access storage for solution. In addition to local input, the system is geared up to accepting off-site inventory transactions via a five-channel punched paper tape communication system. The result! Cost per transaction posting was reduced by 25 per cent in addition to obtaining a tremendous increase in control and visibility.7

Another company, Federal Telephone and Radio Company, having converted to source data recording, reports, "...over-all (input) costs are much less, reflecting fewer errors, new information, and faster action to clear up shop trouble. Four keypunch clerks have been freed for other assignments. Manual reporting errors and wasted time have been cut to an insignificant level in the plant".8

The American Bosch Division of the American Bosch Arma Corporation utilizes large random access file processing for controlling the manufacture and procurement of some 15,000 parts used on approximately 1000 end-products. Processing scope extends from a level-by-level net part requirements computation to the issuance of purchase requisitions and shop fabrication orders. Some of the benefits claimed to have been derived from the system are:

1. Reduction of inspection, ordering and set up costs by cutting the number of manufacturing lots - and related paper - processed through the shop.

From the collection of the Computer History Museum (www.computerhistory.org)
2. Increased accessibility to accurate, up-to-date production control records.

3. Indications of inventory shortages in time to take corrective action.

American Bosch states that these and other advantages have already resulted in net savings which are in excess of $120,000 per year.

Conclusion

As indicated by our experience at Hughes as well as others, management information requirements can be met. The hardware and the software is available. We are remiss in our responsibilities if we do not utilize them to their fullest potential.

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