equipment in business is caused by the lack of the development of logical systems that will fully exploit the logical abilities of the equipment available. Too much effort has been expended on trying to transfer available human systems to these equipments rather than attempting to develop a proper definition of the logical system required.

Conclusion

Electronic data processing is becoming a byword in the evolution of the techniques of a scientific approach to the problems of management. The equipments are not an end in themselves and cannot be considered a panacea for the ills of management. Rather they are a tool of management. Their contribution to the improvement of management is entirely dependent on how well the problems of management are defined by the individual practitioners and how ingenious they are at developing means of formulating information for management review and decision-making processes.

Again, we are only on the frontiers of the potential we seek. Hard work and ingenuity will bring success.

We must move carefully and at all times must be in a position to justify our activities. The introduction of improved electronic data-processing systems will undoubtedly contribute to the advancement of the state of the art, but the feeding of bad inputs into faster and more capable equipments will only generate more bad information at a faster pace.

I have tried to point out some of the difficult areas we are encountering to avoid overoptimism. Yet, there is no reason to be overpessimistic. Our eventual goal can be attained, and with the high stakes involved, the significance of the results warrants the all-out effort.

A General Approach to Planning for Management Use of EDPM Equipment

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DURING the past decade we have all been aware of, or have played a part in, a maximum effort on the part of certain dedicated people. The objective of this informal effort seemed to be to convert all clerical and computational work efforts into an automatic, "fire-all-the-clerks, we-can-do-anything" approach to all known business practices. These dedicated people were mainly comprised of data-processing manufacturers, management consultants, scientists, engineers, and administrative line and staff executives and assistants. They usually had a good grasp of a specific problem and felt that this problem or series of problems were sound EDP applications and by extrapolation, proceeded to teach a number of management executives the economics of EDPM installations.

The influence of this effort and the span of time over which it took place were both beneficial. Decision-making management level executives encouraged and at the same time discouraged the advance of clerical automation. Equipment marketing people were forced to compete in areas that they frankly knew were not practical. "If I don't submit a proposal for this application, competition will get the business and it's a rough row getting back in," were frequent comments that we all have heard upon questioning EDP salesmen regarding doubtful or submarginal installation.

Management consultants were asked into the clerical automation area by top executives who respected previous neutral and objective work assignments, many of these management consultants accepted work assignments with the assumption that old and proven "standard" techniques would serve their purposes in this area as they had in many others; others went in with good staffs and did a "down town" yeoman-like job. Still others capitalized on the confusion and helped equalize mass optimism by forecasting dire results if EDPM installations were contemplated and planned without specific help from *their* firm.

Not to be outstripped, many business and newspaper writers and reporters joined in and began to point out the miracles of electronic hardware and its possible effect upon American business organizations and operations. Articles in magazines, in newspapers, in trade journals praised use of EDP equipment as a new industrial revolution and played up the hardware and its speed with almost no references to planning and application problems and costs. Other articles damned the rapid acquisition of EDP equipment. These write-ups blew way out of proportion some pioneering marginal commercial installations, threw serious doubt into management's mind as to the capabilities of their EDP planning

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people and condemned organizational structure for permitting such a cancerous growth to survive.

Systems people and EAM operators also feeling a need to keep abreast were schooled in electronics. In many cases, they forgot traditional good systems concepts by tailoring work areas and good systems concepts to the convenience of a preselected "brain"; this was done to get into business as soon as possible.

To sum this up I would like to quote two individuals who have different viewpoints and yet a mutual understanding of this problem. John Diebold, President of John Diebold and Associates, in an address to the Eleventh International Management Congress said, "Automation has presented management with a major new problem. As yet management has not faced up to this problem and is hardly even grappling with it in any true sense. This is through no lack of energy or good intentions. On the contrary, the very activity of management in this sphere attests to the progressive spirit and desire for improvement that characterize the modern manager. The trouble lies elsewhere. Automation has turned out to be a much more complex and difficult problem than was originally thought. This being the case, the current disposition to minimize its revolutionary and novel aspects is more hindrance than help in putting automation to work."

The other gentleman that I must quote, to successfully set the stage for this general topic, is an EDP equipment manufacturing top executive. He is one of a half-dozen human beings who have successfully bridged the gap between an exacting technical knowledge of EDPM and the work that management *should* plan for this equipment. Just recently, he asked when American military, industrial and institutional management was going to use *properly* the equipment already produced and *plan* the right scientific and data-processing jobs for it to accomplish. He went on to point out that there is enough data handling equipment already produced to process all problems that our economy needs to handle —providing this equipment is properly programmed and properly distributed. Sound planning is the answer.

The need for planning prior to major commitment in most endeavors is apparent. A football team plans so that all eleven men work together to achieve a first down or a touchdown. In business, profit planning, sales planning, product planning, and production planning are present in most organizations and normally are predominant factors in successful achievement of objectives.

Formal planning has not been adopted for orderly consideration of electronic hardware by all business, military, and other forms of organizations. This is primarily due to the apparent desire of many functions of an organization to 1) jump on this bandwagon (or get left behind), 2) to control this monster which could completely dissolve current organization, 3) to merely extend current punch card applications through the electronic barrier, or 4) to ignore the entire subject until EDP has become a proven practical factor in other organizations.

With the possibility of huge expenditures for programming, for building computer sites, for selection of appropriate systems applications, and for the hardware itself, an organization should begin to plan for successful planning, for it is essential in all forms of planning that a fundamental design and approach to planning a subject be created. Such a design for EDP planning must take into consideration scope, organization, and the ground rules or administration of a planning function itself.

To discuss this on a general basis, due to the number of extremely different forms and types of organizations represented here, let us first examine some possibilities of designing "scope" into an EDP planning function.

Scope

Planning latitude may be extremely broad if you are functionally responsible for data processing in a multiplant industrial complex or it can be extremely limited if the characteristics of the enterprise are small and processing requirements are simple. To my knowledge, there is no formula for determination of planning scope. Some questions may help in formulating this portion of your design for EDP planning:

1) Should the plan point long range, at the immediate, or both? What should the plan achieve? Are planning objectives understood by all concerned?
2) Is the planning concerned with a part or all of a specific application?
3) Should planning review present punch card applications, present manual operations, or should it also encompass data processing for new management decision-making techniques?
4) Is planning required for all portions of an industrial enterprise or are we only concerned with a division, a plant, or a single function at corporate, division, or plant level?
5) Should planning be pointed toward data-processing economy or in specific work areas do accuracy and speed take precedence?

The scope of planning cannot be completely determined without a review of the planning organization and its place in the organization.

Organization

1) Where should the staff work of EDP planning take place in the organization? Is central planning required for product planning, for profit planning, etc? Can economies be gained by centralized planning or are products and data-processing problems so different that plant or divisional planning is essential?
2) Can a combination centralized-decentralized form of planning work? Does this provide greater flexibility?

3) How should the planning group(s) be organized? What should the relationships be to systems employees?
4) What should be the make-up of the planning group or groups? How many staff workers should participate? What background, educational and experience levels should be utilized?
5) Should committee action be employed?
6) Should line employees contribute?
7) What part, if any, should outside consultants perform?
8) Equipment manufacturers—should they be asked to contribute data or ideas during planning and decision making?

After a proper organization is decided upon, management must decide upon a proper set of ground rules or administrative routine within which the EDP planning will operate.

Planning Ground Rules

1) Is planning to be specific or broad? Is the plan to be fixed or flexible? What happens to the plan if broad procedures or organizational patterns are changed during or after completion of the plan?
2) How much documentation will be required? Should progress be periodically or occasionally reported, and if so, to what level or levels of management?
3) What preplanning bench markers can be established to enable management measurement of planning progress?
4) Should management decision be requested during, or only upon completion of, a review of the entire planning scope?
5) In what detail should management participate during planning steps? What information must management have to make final decisions properly—all the detailed technical data or broad approximations of cost and estimates of anticipated results?
6) Should fact finding be accomplished by a planning staff or should all components contribute factual data?
7) Is it necessary to sell staff work and EDP planning prior to the planning action?

These question areas are representative of the many decisions that should be made before initiating a thorough corporate-wide planning survey, or in performing a feasibility study at division or plant level. The list of questions is not a complete check list, but may be helpful in creating a list for a specific organization.

Planning work that can be measured and evaluated is difficult in itself, but when initially directed toward EDP, difficulties in the planning process may be amplified due to communication problems and due to many organizations' inherent caution and fear of possible changes.

Planning work and staff work are not new to most American military men or to business firms. An important contribution to the acceptance of a complex program is the attainment of prior success to create an aura of reliability in those executives that have so performed. Therefore, design for the plan is especially important during an initial planning process; in many cases the "chips" are great, and as in baseball, the batter either gets on base or he is out. In many more cases, however, successful use of EAM equipment plays a significant role in preparing for formal planning.

At Chrysler our planning had to be initiated by superimposing a fact-finding and investigatory stage over an existing broad and, in many cases, extremely *good* data-processing system. This system utilized medium and large EDP equipment along with EAM equipment at various levels of organization. It was largely created by breaking off an existing installation (manpower and programs) and, for geographic purposes, a new installation was then originated. A good amount of systems work had been accomplished, but this area needed extensive work to restrengthen approach concepts as well as to institute much-needed machine room documentation, administration, and control. A total of 42 machine rooms were in existence with over 1200 employees working on data-processing equipment. The comptroller was then informed of the need for a formal plan to investigate work areas and techniques; this review would then expand into an over-all systems study that envisioned examination of source data pickup to finished management action or information reports. He agreed.

EDP planning at Chrysler is the staff responsibility of the Manager, Systems, and Procedures. Data processing is an important management instrument in our company, and we have tailored our systems and procedures organization to place proper emphasis and yet not overemphasis upon the subject of data processing. Our management believes that a correct balance between the work and programming effort of good systems concepts planning and mechanical and EDP planning people must prevail.

An Assistant Manager, Corporate Systems and Procedures, has been delegated the specific and full-time responsibility of EDP and EAM planning and control. His organization comprises three sections, each headed by a supervisor; they include 1) Operations Research, 2) EDP and EAM Administration and Control, and 3) Planning. Our Planning Section is made up of eight employees who have between 3 and 8 years of practical operating and staff experience in this specific field. Most have college degrees in mathematics, in business, or in engineering; however, some of our finest staff work has been accomplished by personnel with much less formal education.

Initially our planning was purposely geared on a broad basis to securing factual data and, on the first pass, to point out specific areas in which immediate new or remedial work should be initiated. Our preliminary

plan was half completed when we discovered a need; a need for a better way to handle those jobs (in a large industrial complex) that due to low unit costs, minimum elapsed time requirements, and with little additional communication costs, made a large computer a natural.

As in any flexible planning technique, new base lines and facts were developed, and after proper delineation and documentation of the new computer's planning and operating organization, the over-all plan was reinstated. You will note that specific and detailed operating planning, after a management decision has been made, is separated from the staff planning work and in effect proceeds through its own planning cycle within a specific predetermined scope and time limitation.

The broad-gauge, corporate-wide planning is then continued with new factors and perhaps with new ground rules that have resulted from the major decision passed down by the top management. Continuation does not mean starting over, but it does embrace a review of the planning process to date. This planning process entails 1) reaffirmation of objectives, 2) analysis of the new situation, 3) determination of planning routes and manpower requirements, 4) choice of alternate course to be initiated, 5) conversion of choice into action steps, 6) creation of internal and external communication channels, 7) determination of planning and methods of appraisal, and 8) then a procession through these same steps after evaluations indicate that changes in the planning process should be incorporated.

Specifically, our current plan which will be presented again to top management in the near future has the following *objective.*

> It is the objective of the Corporate Systems and Procedures Department, through the development and eventual approval and adoption of this and succeeding planning efforts, to provide Chrysler Corporation with the most effective management information systems in the Industry.
>
> The need for *constant* and *continual* planning is a fundamental requirement to successfully integrate, coordinate and effect such a dynamic data handling system. Competitively this is a must for Chrysler.
>
> In general, we have just scratched the surface in the data handling field with the mechanization of some of the "safe" clerical functions. These functions have provided valuable experience in data processing techniques. On occasion, we have used the logical abilities of data handling equipment to provide meaningful data for the control and regulation of manufacturing processes and to directly help to improve our product quality. However, at the present time most of the data generated merely reports the status of operations, produces necessary checks and notices, but is rarely employed to provide recommended actions for timely operational decisions. Ultimately, a data handling system will be evolved that will provide this needed decision-making information, and select action courses for more consistent and precise control at all levels in the organization. The program to effect this plan will not remain static for any long period of time, but must be continually reviewed to reflect new data processing product development, new systems concepts, and progressive changes within the corporation.

After formally stating a purpose, it is frequently necessary to state the base line, or present situation, which helps form the scope and direction of our planning in the minds of the planners and decision makers. The present status should be concise and complete; any decisions that have been firmly made, but not as yet implemented, should be "baked in" as part of the plan initiating point. As decisions are made, this part of a plan package will change; such decisions should be formally reflected and should be documented so that at any time that management decision making may occur (and this process could be almost continuous) an up-to-date document can be presented to insure fact-founded decision.

A typical *Present Status* should include:

1) A statement and exhibits to indicate present data-processing installations.
2) An exhibit indicating the size, geographical location of these installations, along with an indication of communication media.
3) The basic type of equipment employed and their cost or rental.
4) An analysis of the number of people involved in data processing and the annual cost including fringe benefits.
5) A statement and chart that indicates the current organizational placement of data-processing components throughout the corporation.
6) A chart indicating functions and work areas that are being handled by data processing for each installation within the corporation.
7) A detailed statement indicating the history of a representative data-processing component; how it grew, what jobs it is now performing, what basic costs would be incurred if automated techniques were not employed.
8) An indication of the training and supervisory talents that present job incumbents possess.
9) Examples of areas in which improper control and improper organization, lack of documentation, poor systems concepts, etc., are contributing to erratic and faulty data processing.

Current planning progress should then be indicated to show positive staff and line, central and decentralized work effort that has resulted from the over-all planning efforts. This should include such progress as:

1) Training programs initiated by corporate or machine manufacturers to increase the scope of employees' work efforts through greater knowledge of new concepts or machines.
2) Training programs to teach supervisors and machine procedural planners the latest administrative, documentation, and control techniques.
3) Installation progress of approved EDP equipment or of new or combined EAM installations.
4) Major conceptual developments initiated at any EDP installation.
5) Disclosure of *preliminary* detail plans that look promising (although in which sufficient staff work has not been accomplished to secure final decision).

6) Development of community or employee communications designed to "sell" data processing.
7) Progress made in report and problem solution areas entirely foreign to data processing at this time; using techniques such as simulation, or by tailoring mathematical models of problem areas, thereby establishing entirely different methods for better and more accurate management decision.

The next section of a planning package may be a review of the development of short-range programs, as they relate to a long-range program. This program development review should include:

1) A concise statement of problem areas; personnel outside of the planning section should be asked to supplement and/or modify a list of these areas.
2) A brief statement as to the proper remedial action that must be taken to correct existing problem areas. Again, the considered opinion of line and staff executives should be requested during the formulation of the short-range action plan.
3) New problem areas currently not processed mechanically or electronically; these should be defined and should be investigated in terms of possible application and solution by use of different source information or processing techniques.
4) A firm schedule against which periodic progress reports may be measured.
5) Using the aforementioned four steps, a general statement recording 1-, 3-, and 5-year goals of information handling should be spelled out. This should include a statement specifying the planning philosophy and the general direction in which the plan is approaching the stated objectives.

In closing, EDP planning is a repetitive, dynamic process that, to be effective, is flexible and when intermediate decisions are made, should be re-created. It may be worthless if used as a pure academic exercise. A plan is considered and then may be rejected or partially or completely adopted. In any event, it has served a purpose. EDP planning should be tailored to the total enterprise, to top management individuals, and to the background of previous good or bad experiences with EAM or EDP applications. Planning recognizes that staff members do not have a patent on brains. Factual and idea contribution must be encouraged and developed. It should not always result in an EDP application; in many cases, byproducts of EDP plans and feasibility studies are more valuable than the EDP results themselves.

De-emphasizing hardware, it should place much more stress upon approach concepts and related facts.

EDP planning should be kept practical and should engender continuing enthusiasm on the part of the planning staff. It is not an end in itself. The only reward of good planning is its influence upon management, which results in the achievement of stated objectives.

Dynamic Production Scheduling of Job-Shop Operations on the IBM 704 Data-Processing Equipment

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FIRST, let us explain what we mean by job-shop operations. In this case we are talking about our Jet Engine Department in the General Electric Company, Aircraft Gas Turbine Division. The Jet Engine Department is the step between the basic concept development and the production shop. Their manufacturing facility is responsible for building engines and components and for testing these engines and components to prove practicability of design, serviceability, manufacturability, and reliability. The prototype engines are also within their manufacturing responsibility.

From this, one can visualize the type of operation about which we are speaking. It is largely one where Engineering requests parts to be manufactured for installation into an assembly which is to be tested. The important thing is that there are a large number of requestors and relatively few items per request. Stated another way, this means no schedule of incoming work. Hence, the name, job shop. Fig. 1 represents the flow of operations just discussed.

Now that we have seen what a job shop represents in our case, consider the size of our operation. There are approximately 9000 operations on order in the manufacturing shop at any one time. These operations may represent two or three thousand requests with several

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