MANAGERIAL PROBLEMS IN DESIGNING AND ORGANIZING A LARGE COMPUTER SYSTEM FOR INVENTORY CONTROL

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As you may know, a recent survey by McKinsey & Company, Management Consultants, determined that industry has installed only a limited number of computer applications which contribute substantially to the improvement of managerial decisions. It appears that to date, industrial organizations have been successful chiefly in the installation of programs which vary only slightly from applications handled on tabulating equipment - except for increased processing speed. The McKinsey study concludes that the absence of what is called "decision-oriented applications" explains why most computer installations are unprofitable when return on investment and cash flow criteria are considered.

At General Foods, we have had installed since April of 1961 a large-scale, computer-based inventory management system called COPT - short for Cost OPTimization. Although this system is far from theoretical perfection, it is generally considered by people inside as well as outside General Foods as a successful large-scale application.

Your program chairman suggested that some of GF's experiences in getting COPT operating would be of interest to you. I think I can tell you the COPT story best by describing the twelve principal elements which, in my view, have contributed most to GF's success.

I would like to make very clear at this point, however, that not all of the managerial approaches which I shall discuss - in fact, perhaps none of them - may be applicable to the operation of any other company. At the least, however, GF's experience and approach, if reviewed with considerable care, ought to stimulate some rewarding thoughts in this vital operational area.

First, a few words about Cost OPTimization - COPT - itself, how it operates and what it accomplishes. The GF Distribution system in the United States and Canada consists of 50 warehouses, each stocking an average of 250 unique items. The movement of goods, invoicing, preparation of shipping papers, and so on from these warehouses to customers is controlled by 25 Distribution Service Warehouses, operated by a single, non-profit Service Division. The warehouse system is supplied out of 17 producing plants, each of which specializes in production of a limited number of items for a specified geographical area. These plants are the manufacturing arms of several, highly

decentralized GF operating Divisions. The profit responsibility is located and accounted for in separate Departments within each Division. Here is what the COPT system does:

> First, it provides every week sales forecasts of customer shipments for each item and at each warehousing location and does it for eight weeks ahead.
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> Second, the system identifies shipping and manufacturing priorities for each item and prepares recommended manufacturing, raw materials procurement and car make-up schedules every week. This is done for a GF product line with an annual sales volume of about one billion dollars.
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> Third, the system reviews each Friday night, and subsequently every other day on a limited basis, all warehouse stock positions, all in-transit, all unshipped orders, customer service standards, transportation lead times, factory production schedules, etc., - and delivers to every plant in the United States and Canada a variety of reports which focus on specific problem areas.
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> Fourth, the system accepts statements of opinion, rather than fact, as to the timing and probable effect of any promotion, deal, or product introduction - modifying its forecasts and production schedules accordingly.
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> Finally, the system provides the informational framework for reconciling conflicting interests between Distribution Services vs. Production Scheduling; between Purchasing vs. Production; between Finance vs. Sales and between Distribution Service vs. Sales. As you know, each of these Departments has differing interests as to inventory policy.

The overall informational flow and system features are shown in exhibits attached to this paper.

So much for general information. Now let me get to the purpose of my talk - a description how the system was installed.

Element #1. Project Selection

Three years ago the project was initiated by the Operations Manager of one of the Divisions, who had an immediate problem to solve. In other words, the project did not originate from a staff group as a general study, it was not originated as a top level dictate. The project began quietly, modestly, with highly focused and unambitious objectives. I believe that initially it is possible to make great progress in the computer field without an overly elaborate planning framework, simply by tuning up your organization to be responsive to the immediate needs of operating people. In the case of COPT this proved to be the case.

Element #2. Project Organization

The Operations Manager hired, on an out-of-pocket basis so far as his profit center was concerned, specialists from Corporate Staff to do the job on a limited budget of $20,000, with the limited scope of only a few products, with specific objectives and an implementation schedule of less than eight months. The Corporate Staff Consultant had access without reservation to the entire operating organization. There were no Committees. Data gathering and fact finding was done by the operating people who would have to implement the system, rather than the staff people themselves. So far as the Production Scheduling and Distribution supervisors and clerks were concerned, it was going to be a system developed by them, under their own direction. From the very start there was no question whether the system will or will not be installed. The old set-up was clearly inadequate and hence the only question remaining was how far-reaching the new system should be. Obviously, this cost of environment makes for high creative motivation. The "line" operation also assigned a key manager who spent more than 50% of his time on the project. Incidentally, this approach differed considerably from the situation which prevails in the majority of corporations, where O/R staff must "sell" line management on improvements. Since Operations paid for every penny of the system, money was spent wisely, dispensing with elaborate reports and costly data-gathering by staff specialists.

This form of organizing materially contributed to good progress.

Element #3. Programming Effort

Inasmuch as sophisticated, mathematical equations were involved in the system, an outside programming consultant with considerable prior experience in design of similar system was selected to do the bulk of computer coding. This allowed incorporation of many advance system features which the in-house programming organization did not possess. This element then accounted for the unusually short implementation schedule.

Element #4. Computer Selection

Although GF has today 17 medium-scale computers of the IBM 1401 class, the principal computations of COPT are still done on an IBM 7094, rented for about 90 minutes each week on a Service Bureau basis.

Our own computers now prepare the edited input on magnetic tapes, which are then ferried by car to the large computer. The lack of inhibition at the outset to select a large computer to handle complex computation has substantially contributed to the power and low operating cost of the entire system. Since installation of a large computer prior to the selection of suitable applications can tax the managerial and technical resources of an organization for several years, just keeping the machine loaded and utilized, GF's selective use of an outside computer proved to be a good decision. It speeded up the installation of COPT even before our own medium-scale computers emerged from their inevitable initial conversion difficulties.

Element #5. Educational Investment

It is estimated that 2 - 5 times the cost of the mathematical, systems and programming work was spent in education. Relatively low-paid clerks with little formal training in inventory management, who are the recipients of the various COPT reports, ultimately are the people who either will make the system fail or succeed. Formal classes with final exam were held for personnel assembled from all over the country. Incidentally, such meetings are still held. Any time the system is modified, a user's conference is held at corporate headquarters in White Plains. The importance of this element cannot be overemphasized. As a matter of fact, any substantial scaling down of the educational program would have wrecked the entire system.

Element # 6. Documentation

One thing that has not been skimped on is detailed documentation, from a user's point of view. All of the logic and relationships in the system are carefully defined in manuals. Every user of COPT reports - and their number may be now over 100 in GF - has a comprehensive procedural manual which, hopefully, enables each individual to fully comprehend how his job effects every other in the system. The function of documentation is closely related to the educational investment, mentioned previously. I am isolating it, however, to point out that good documentation is one of the cheapest and most effective ways of getting the educational job finished.

Element #7. System Design and Maintenance

Since its inception, COPT has grown by gradually assuming the inventory management function of all GF Divisions. During this period of growth, considerable modifications had to be made in the system to accommodate different operational circumstances peculiar to each product line.

From its inception COPT was priced to user Divisions identifying the unit cost of each optional feature. Since the entire computer system is designed on a strictly modular basis and the needs or know-how at each Division and Plant vary, each participant in this system can choose from the features price list exactly that combination of reports that he wishes to use. Individual divisions or even plants are also given the option to disregard the system altogether, since no Corporate staff group has the power to dictate what is best for any particular production scheduling and distribution management operation. The absence of any firm dictate imposing absolute uniformity, and the retained right by all users to "secede" from COPT, has turned out to be one of the system's principal sources of strength.

Inasmuch as all COPT operating costs are related to actual user needs, the corporate department which administers COPT for the Divisions, has always had adequate funds to provide the services requested on an ever-increasing scale. Any program modifications, if requested by a single Division, are paid for on a direct reimbursement basis and are made freely available to anyone else merely for operating costs. Under these conditions and relationships, there has been a steady influx of funds and of voluntary participation.

This flexibility in basic systems design and administration of the COPT program then became the key to providing a highly sophisticated and centralized service in a large decentralized company.

Element #8. Competition

Because COPT is internally operated as a consulting service, it has to meet competitive challenges from Divisional computer staffs as well as from outside agencies. This environment has encouraged a continuous effort to lower unit operating costs, to develop new system features and to integrate the system with local needs.

Even though the informational power of the system in the last two years had increased by a factor of about 2, the systems' unit costs have been more than halved. For instance, it costs us now less than 4¢ to make a sales forecast, as compared with roughly 10¢ before.

Personnel administering COPT have found new and ingenious ways to stretch the scope of the system. For example, even though most of the system output in printed form is mailed out over the weekend to plants in the United States and Canada, increasingly this is supplemented by punched card or punched tape output to be reintroduced in a local EDP installation for further processing.

Element #9. Research and Development; Program Development and Maintenance

A limited amount of residual funds are continually reinvested to cope with new problems as they arise. Such funds, combined with costs of modifications, have increased the costed value of COPT computer programs to about $250,000 and have resulted in a number of novel ventures into better information processing. The most noteworthy here are the COPT features capable of incorporating the sales department's judgments, the extension of COPT into raw material management even to the supplier level, and the currently planned incorporation of warehouse space management evaluation as an integral part of inventory management.

Element #10. Organizational Consequences

The introduction of COPT has not resulted in any major organizational disturbances. By centralizing the computing power and formalization of communications in and out of the computer, COPT has permitted a measure of decentralization of decisions to the plant level on a scale previously undreamed of.

Today, for instance, a clerk rescheduling machine assignment for the third shift on a Thursday night possesses the capability to perform a fairly rigorous analysis of the marketing, transportation, customer service and operating consequences of his decisions. Even though COPT has reduced the number of clerks necessary to perform the expediting function, it has increased the number of clerks who must carefully study the broader issues of their inventory management actions. Hence, the system has not reduced the number of administrative people. However, by displacing most of the short-term dicisions from Divisional Headquarters to the Plant, it has permitted Divisional people to concentrate on long-range decisions which previously, often went unresolved due to the constant pressure of immediate emergencies. The net result of all of this cannot be readily seen on an organization chart. It can be seen principally in a series of personnel moves resulting in the overall upgrading of the talents of people responsible for the inventory management function. If you can afford to accomplish such a displacement in people gradually, as we have been doing in GF, you may find this method a preferred way of achieving success.

Element #11. Input Reliability

One of the biggest problems that has plagued COPT is receipt of sufficiently reliable data. To run a centralized mathematical computation of desirable production scheduling objectives and inventory requirements is a very difficult task if your distribution system is geared to prompt customer service in excess of 99.9%, and when an operating inventory level substantially below 6 - 10 weeks supply is sought. This means that perpetual inventory and sales records at 20 different EDP or EAM locations must be maintained with close to 100% accuracy, transmitted over telephone circuits without loss of significant digits, processed through 2-3 computer installations and transmitted back to plants within 36 hours for the weekly analysis and within 12 hours for the two supplemental analyses done during the week. Consistently, the sheer technical burden of threading hundreds of thousands of significant digits through as many as 5 data processing points, each modifying and interpreting the output of the previous step, has been one of the most difficult challenges to COPT.

There are no finite answers to this problem. We have managed to cope with errors by imposing elaborate editing and checking routines throughout the system. Today, well over 80% of inventory management data processing costs are in input data preparation and output editing, rather than in the operations research-type computations.

Another means for preventing the automatic computer mis-allocation of production and inventory resources is by increasing the capability of people to monitor the performance of COPT. COPT is now geared to produce a number of diagnostic reports and messages which are designed to attract intervention by judgment. For instance, the computer checks its input for completeness, partial relevance and identifies conditions where predetermined maximum limits are exceeded.

Element No. 12. Tackling Apprehension

Frankly, many operating people are suspicious of computers operations researchers and mathematicians. The general notion exists that somehow computers are going to displace imperfect humans. Considerable distrust, opposition and apprehension can, therefore, attend the introduction of a system such as COPT. I would, therefore, say that the greatest portion of all managerial problems in designing and organizing for a large scale computer system could be avoided if:

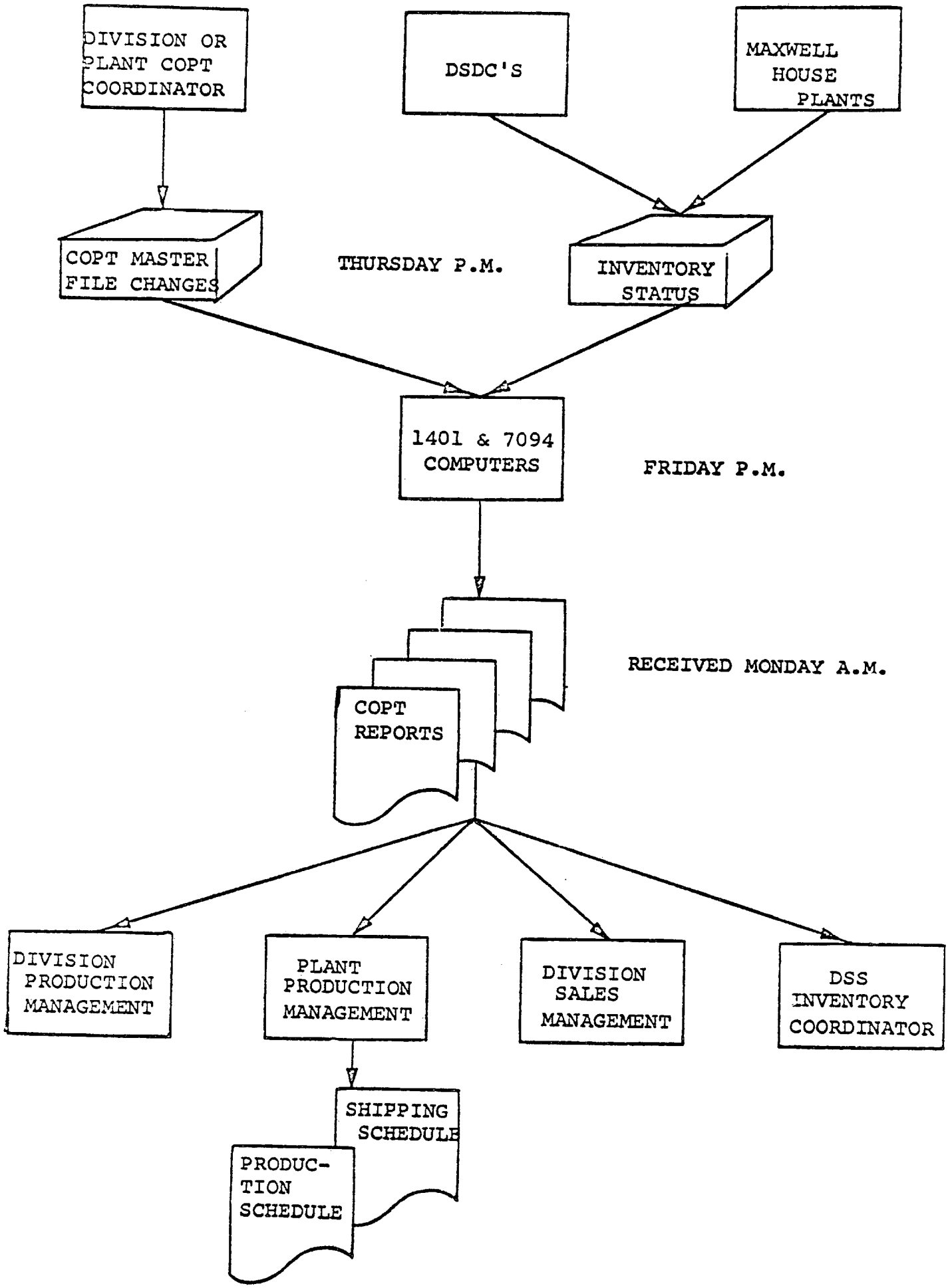
(a) the Corporation itself is well managed and its operating people are motivated to ever larger efficiencies and profits.

(b) if the operating people are sufficiently capable and willing to look to staff specialists for innovation and as a source of new technology.

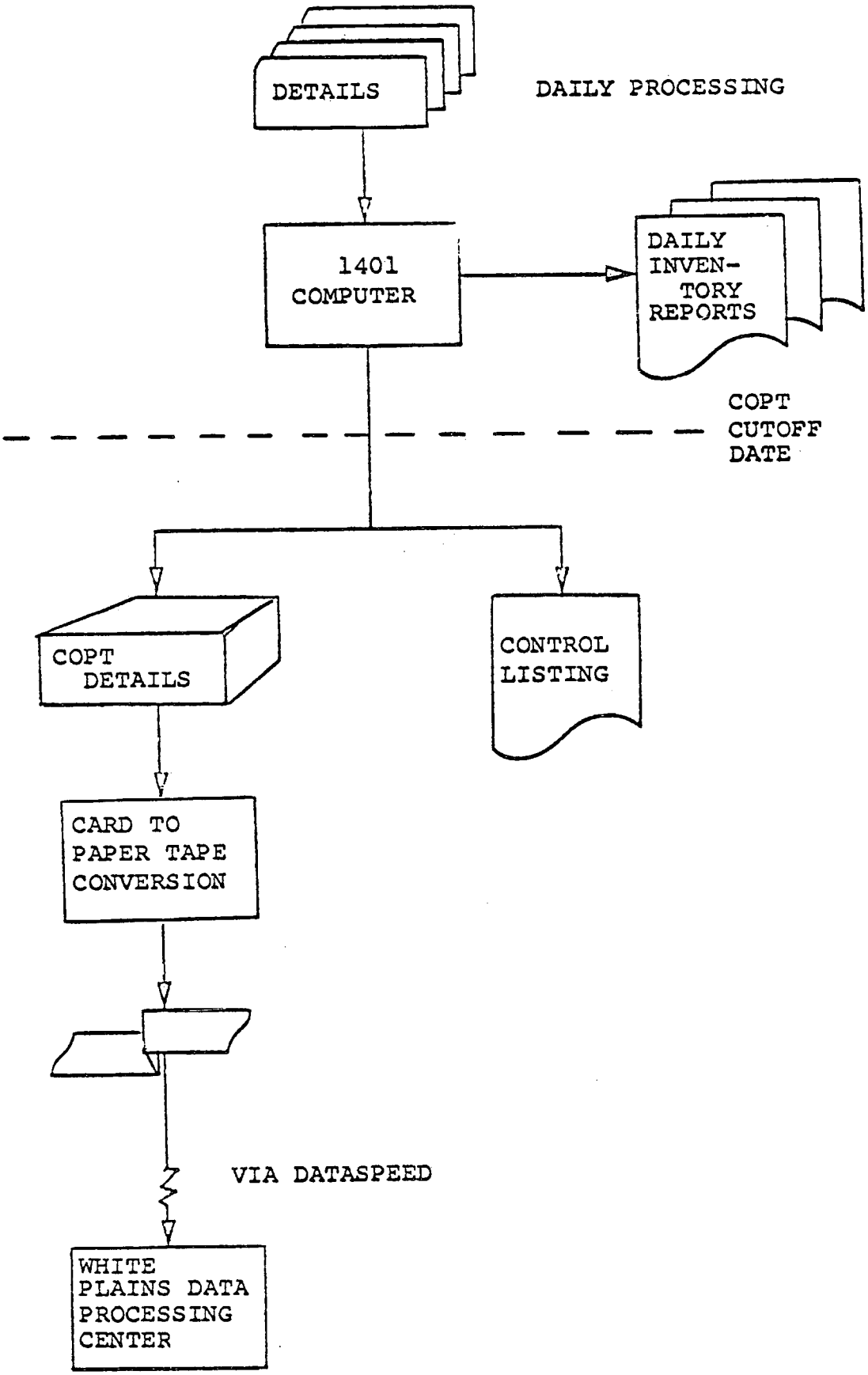
(c) if the computer and operations research people are capable of satisfying the immediate needs of the people they serve, if they are willing to subject their work to the same criteria of effectiveness and profitable performance as may be expected from everybody else in a well-run enterprise.

In conclusion, let me say - that the above conditions were met satisfactorily by General Foods people, which explains why the Cost OPTimization inventory System has become an accomplished fact rather than just another unresolved managerial problem.

COPT SYSTEM WEEKLY DATA FLOW



DSS DATA PROCESSING FOR COPT



COPT MASTER RECORDS

1. CONSTANTS FILE - AN 80 CHARACTER RECORD FOR EACH PRODUCT CODE - WAREHOUSE COMBINATION. PURPOSE - EDIT AND CONTROLS.
2. HISTORY FILE - A 214 CHARACTER RECORD FOR EACH PRODUCT CODE - WAREHOUSE COMBINATION: PURPOSE - STORES HISTORICAL SHIPMENTS, TREND, FORECASTING ERRORS, AND CYCLICAL SALES PATTERNS FOR FORECASTING MODEL.

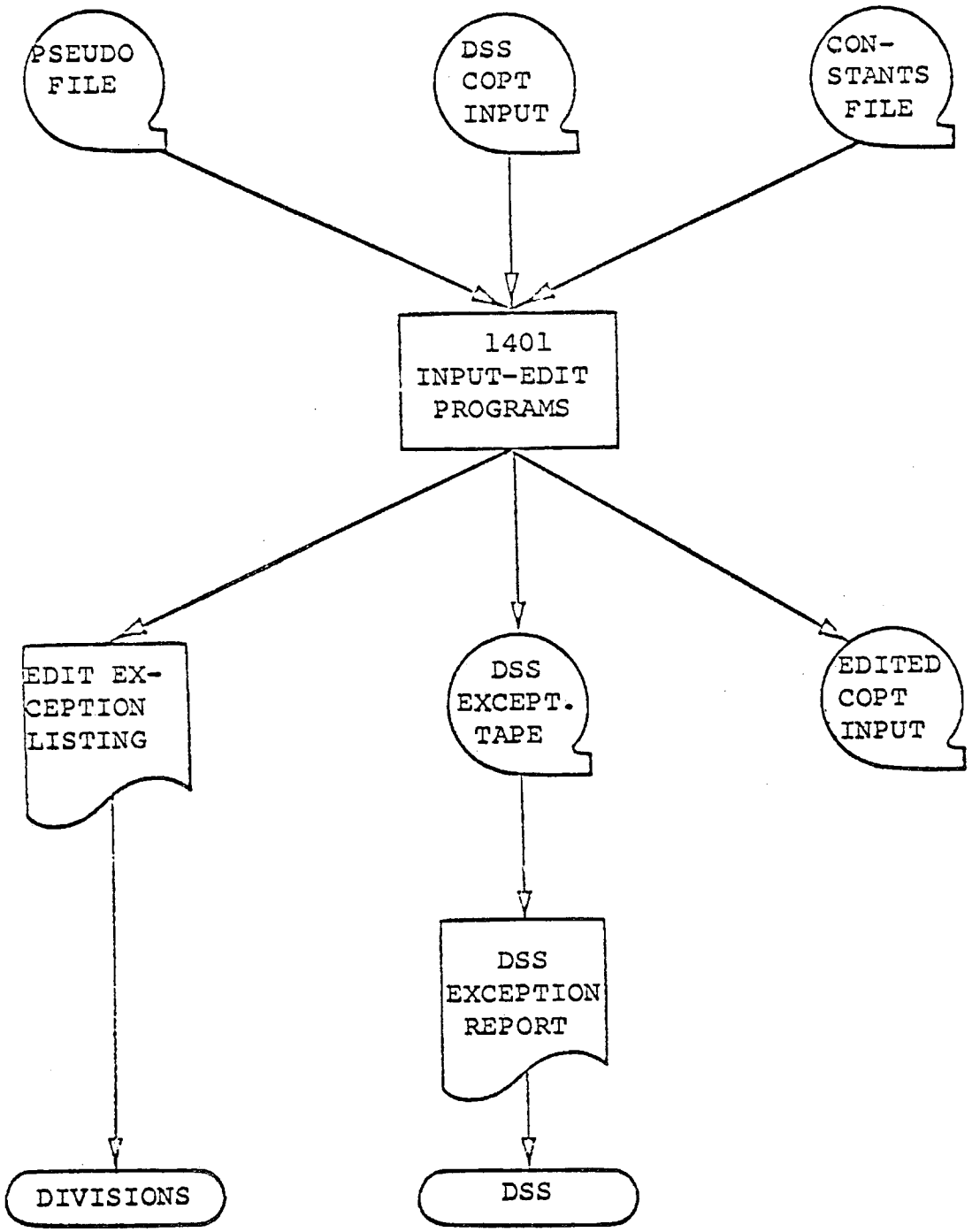
*3. DEAL CONTROL RECORD - AN 80 CHARACTER RECORD FOR EACH PRODUCT CODE - WAREHOUSE DEAL ACTIVITY. PURPOSE - USED IN FORECASTING SALES OF DEAL CODES AND IMPACT ON STANDARD CODES.

*4. PSEUDO ALLOTMENT RECORD - AN 80 CHARACTER RECORD FOR EACH PRODUCT CODE - WAREHOUSE, AS REQUIRED. PURPOSE - TO CONTROL PHASE-OUTS OF OLD PRODUCT CODES BEING REPLACED BY NEW CODES: OFFERS OPTIONAL METHOD OF HANDLING DEALS.

*5. SHAPE FILE - AN 80 CHARACTER RECORD FOR EACH DEAL TYPE, BY WAREHOUSE, FOR EACH DIVISION, CONTAINING EXPONENTIALLY SMOOTHED DEAL FACTORS. PURPOSE - USED IN DEAL FORECASTING EQUATIONS.

*OPTIONAL FEATURES

COPT INPUT-EDIT DATA FLOW



GF SHIPMENTS FORECAST PROGRAM