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Management Information Systems in Retail Food Firms

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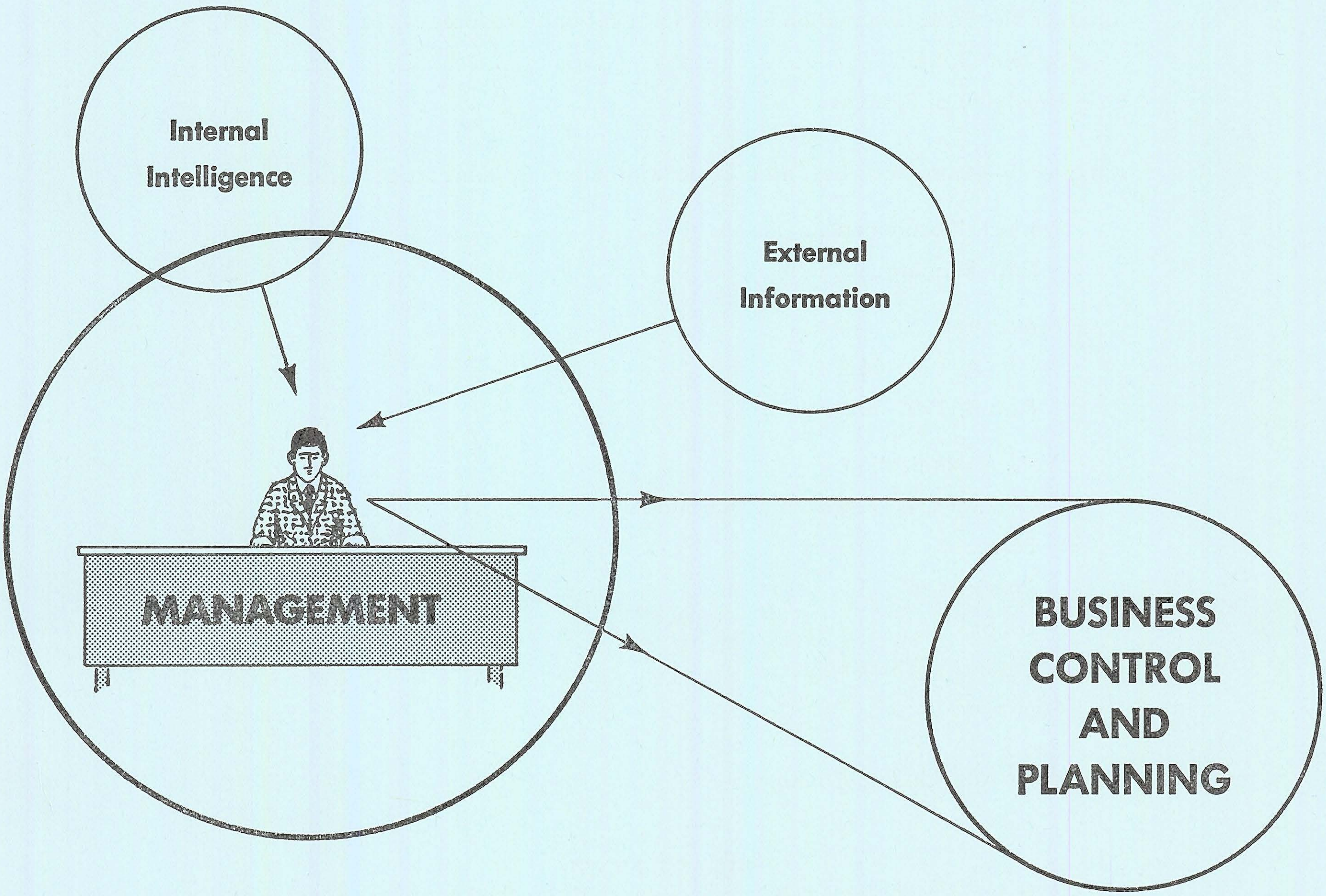

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PLEASE NOTE

A technical supplement to this bulletin contains the programs, operating instructions, and labor coefficients for the OARDC information systems for meat and produce operations. This is available from the senior author upon request. Ask for ESM 489, Management Information Systems in Retail Food Firms: Technical Supplement on Computer Programs, Department of Agricultural Economics and Rural Sociology, The Ohio State University, Columbus, Ohio 43210.

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MANAGEMENT INFORMATION SYSTEMS IN RETAIL FOOD FIRMS

B. W. MARION and LLOYD T. BAY

FOREWORD

The material in this bulletin draws upon research conducted at the Ohio Agricultural Research and Development Center by the senior author and several graduate students over the past 9 years. Most of these research efforts were cooperative endeavors with the U. S. Dept. of Agriculture. The initial research, in cooperation with the Economic Research Service, U. S. Dept. of Agriculture, studied the labor requirements of retail meat departments, analyzed meat product movement, and developed on an exploratory basis a linear programming profit maximizing model of retail meat operations. It became apparent during some of this early work that until computerized information systems were more widely developed in the industry, much of the research had limited chance of application.

The latest research effort was conducted in cooperation with the Agricultural Research Service, U. S. Dept. of Agriculture. It concentrated on developing demonstration-type information systems for produce and meat operations, and on further explorations into short-run forecasting models for meat product sales at the individual store level. The results of the forecasting work will be reported more completely in another publication, although some of the highlights are included in Chapter IV of this bulletin.

Management information systems represent a relatively new area of concern for both industry and academic personnel. As such, empirical results are limited, particularly in the retail food industry. Questions concerning the desired scope and organization of such systems, the impact of systems on the firm organization and personnel, and the cost-benefit ratio for various types of systems are therefore difficult to answer in a carefully documented and empirically supported way. Reliance is thus placed upon the relatively few studies which have been conducted (for the most part in other industries), the opinions and experiences of systems personnel, and of course the thinking and imagination of the authors. It is hoped that what is lacking in scientific evidence will be compensated for by the ideas proposed about this rather new and exciting subject.

Chapters I and II discuss information systems from a broad perspective, bringing to bear much of what has been learned in other industries about "effective" and "ineffective" information systems. Chapter II suggests a logical pattern for the development of management information systems by retail food firms.

The two computer systems developed at OARDC for produce and meat operations are briefly discussed in Chapter III. A more complete and more technical discussion of these systems is available upon request from the senior author (ESM 489, Management Information Systems in Retail Food Firms: Technical Supplement on Computer Programs). The discussion in Chapter III and throughout this bulletin is oriented toward operating management with limited data processing experience.

Since an important contribution of information systems is the potential they provide for employing more powerful decision techniques, Chapter IV discusses some of these possibilities. While employment of the models discussed is common in some industries, their use by the retail food industry is largely in the future. The potential benefits from such models in food retailing are unknown at this time.

This report is most directly a result of a cooperative agreement between the Ohio Agricultural Research and Development Center and the Wholesaling and Retailing Research Branch, Transportation and Facilities Research Division, Agricultural Research Service, U. S. Dept. of Agriculture. Dale Anderson of ARS provided liaison and many useful contributions to the research effort. The assistance of industry personnel, department colleagues, and members of the Computer and Information Sciences Department is also gratefully acknowledged. Finally, a very special thanks is extended to Mrs. Roberta Riddle for her patience and dedication throughout the research effort and in typing the final manuscript.

CHAPTER I
MANAGEMENT AND MISMANAGEMENT OF INFORMATION

"Come into my parlor, said the computer to the specialist." . . . Marshall McLuhan.

Marshall McLuhan, in his thought-provoking book, *Understanding Media: The Extensions of Man,* suggests that man has passed out of the machine age and entered the electric age. In this electric age, the real product is not a material thing but information.[1] Fueled by increasing expenditures in research and development, the generation of new ideas, new knowledge, and new technology has become specialized and institutionalized. The result is a continuous and expanding flow of new knowledge—as compared to the uneven flow of innovations from earlier periods which depended more upon the "chance and genius of individual inventors."[2]

In this electric age with information and new knowledge spewing forth from many sources, the premium is on those individuals or organizations that can effectively tap this flow. As one colleague recently wrote:

"There exists today a tremendous stockpile of information, new ideas, new technology, and it is growing at an increasing rate. Most of it is available to everyone and aspects or nearly all of it can be identified by a really prying mind. But most of us are unaware of it. Most of us are "information receivers," though we know that if we really did our jobs we would be "information hunters!" The more information there is, the greater the payoff for being an information hunter and the greater the price for being an information receiver. Those who wait for information to come to them are among the last to know."[3]

A systems approach to management information involves a definite step toward becoming *information hunters*—not on a sporadic or *brush fire* basis, but on a continual, planned basis. The rapid developments in electronic data processing and communication have made the development of comprehensive information systems not only practical and feasible, but in many industries an increasingly necessary competitive weapon. Those firms which are rapidly developing sound, well-conceived information systems have a clear competitive advantage over their rivals.

[1]McLuhan, Marshall. 1964. Understanding Media: The Extensions of Man. Signet Books, The New American Library, Inc., New York.

[2]Shaffer, James Duncan. 1968. The Scientific Industrialization of the U. S. Food and Fiber Sector Background for Market Policy. **In** Agricultural Organization in the Modern Industrial Economy, Dept. of Agri. Econ. and Rural Sociol., The Ohio State Univ., p. 2.

[3]Stout, T. T. Dec. 2, 1968. "What's Ahead: Blank Check or Blank Wall?" Presentation to Sixteenth Annual Meeting, Agricultural Relations Council, Chicago.

However, not all information systems are "sound and well conceived." A wide range in the caliber of systems is observable in different firms. Thus, before turning attention to information systems for food retailing firms, some comments are warranted about information systems in general.

Information systems are not new. Various types have existed for many years. The Bureau of Labor Statistics, U. S. Dept. of Commerce, has a well-developed system for collecting and disseminating cost of living data and other economic information. The Market News Service, U. S. Dept. of Agriculture, provides a continuous flow of information about the price and quantity of agricultural commodities marketed. Most meat buyers make use of the *National Provisioner* Yellow Sheet as a source of daily price information on livestock.

Many of the information systems used by the food and fiber sector are governmentally operated to provide more perfect knowledge. However, commercial information firms also provide valuable flows of information. Firms such as A. C. Nielsen and Marketing Research Corporation of America provide valuable information on a continuing basis about consumer attitudes and behavior, brand sales, and other relevant marketing information. Within corporate entities, a type of information system has provided management with information on such things as sales, expenses, inventory, and financial condition for many years.

With the rapid adoption of computers,[4] the ability to generate large quantities of timely information has been greatly expanded. Not only have manual information systems been computerized, but substantial additions have been made to the scope of the systems.

This has presented the possibility of truly information-oriented firms; i.e., firms with comprehensive information and intelligence systems which go far beyond reporting operating results and financial condition. In such visionary firms, a continual flow of internal company data would provide sensitive controls to management. Information flowing in from *early warning radars* trained on environmental forces and competitive action would supplement the internal information for planning and strategy decisions. Thus, information seeking and dissemination would not be left to the whims of individual members of the management team. Nor would it be a *nice to have* supplemental activity. It would be the core of the

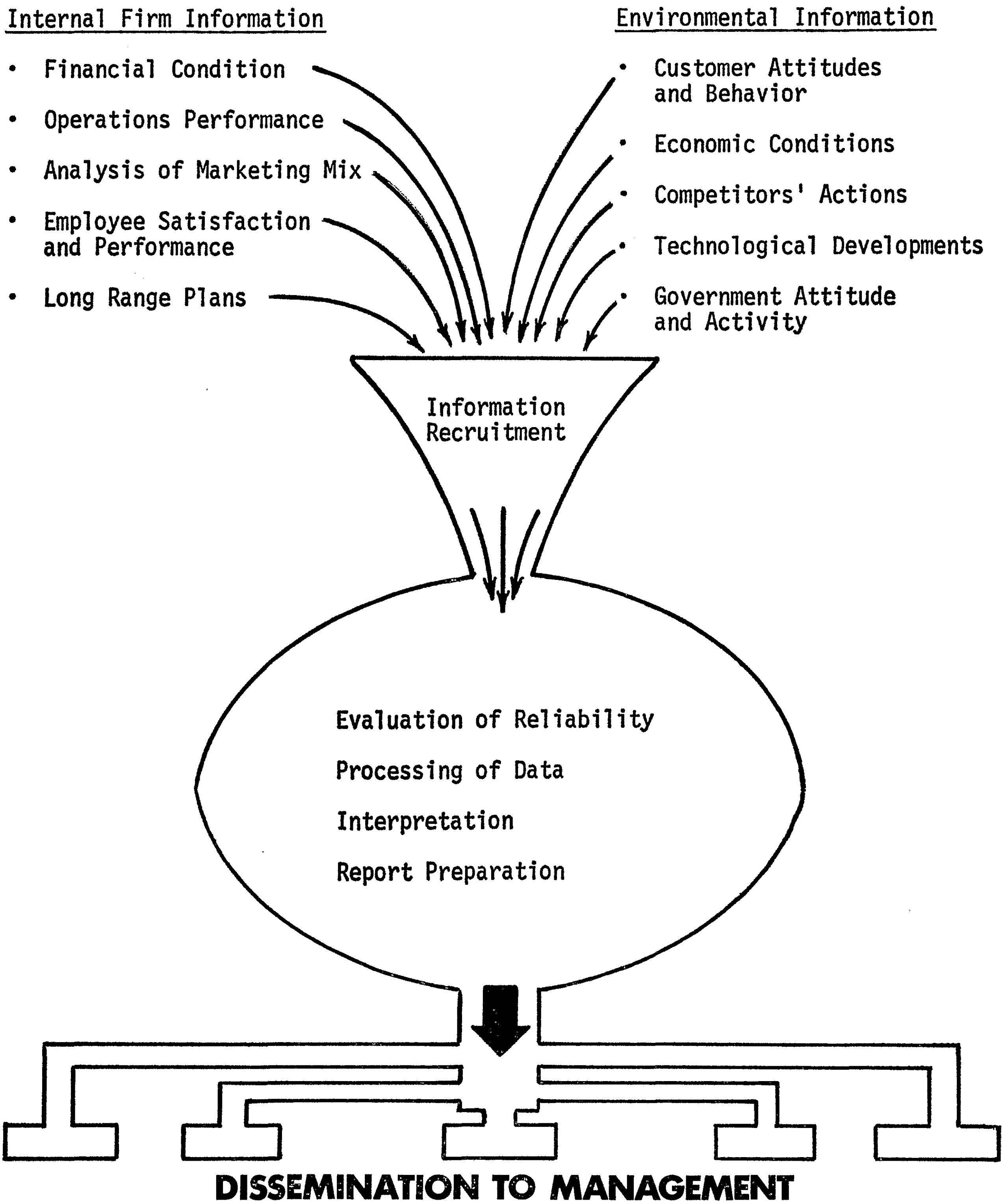
[4]For example, John Diebold in Bad Decisions On Computer Use, Harvard Business Review, Jan.-Feb. 1969, indicates the value of computers and related equipment shipped in U. S. has increased from $600 million in 1960 to $6 billion in 1967, and will approximate $9.5 billion in 1973.

firm—and the basis for nearly all decisions made (Figure 1).

The information manager in such a firm would be one of the most critical members of top management. He might be likened to Adam Smith's description of performance fund managers in the Money Game:

"Performance managers can be very good company, just as diplomats or foreign correspondents or any other group that represents a cross of disciplines

FIG. 1.—Simplified Model of a Firm Intelligence Center.



can be. They have to be alert, they must keep constantly scanning for changes in the environment and for new ideas, because literally anything that happens can have an effect on all that money. They have to be good brain pickers, and a good brain picker is usually alive enough to be a good dinner companion."[5]

This helps reflect the alert, enterprising, aggressive manager needed in an information-oriented and centered firm. However, such a phenomenon is still some time off for most companies. A great deal has yet to be learned about developing effective information systems, and developing management personnel who can use such systems. In many cases, as one author writes, "Management today is faced with more information than it knows what to do with, or can assimilate."[6] The widespread adoption of computers has resulted in a vast increase in the quantity of data which can be practically generated. Without a concomitant increase in efforts to screen the data in order to present management with the type of information—when they need it—and to expand the ability of management to use information, decision makers may be more confused than helped.

Existing Systems—Trials and Triumphs (Organizing for Effective MIS)

The development of comprehensive computerized information systems has been slow, painful, and often wrought with frustration. In the opinion of many authorities, most firms are still far short of realizing the true potential of computers. To quote John Dearden,

"Many companies today are faced with serious problems in utilizing the capabilities of computers. Computers are not being used effectively in providing management with the best information available for decision making; they are not being used efficiently in terms of properly integrating the various information systems. Moreover, the situation appears to be getting worse rather than better."[7]

Dearden contends that the causes of this problem lie in attempting to develop a single integrated system for all information needs in a company, and in organizational deficiencies which give too much responsibility for systems development to the specialists and not enough to operating management. Dearden is not alone in his diagnosis, particularly on his second point.[8]

In studies of 27 and 32 companies respectively, Garrity and Thurston both conclude that one of the essential differences between effective and ineffective computer systems was the degree of involvement of operating management in the selection and manning of computer projects, and the responsibility for the progress of these projects.[9]

In most companies, EDP (electronic data processing) was initially placed in the accounting department. For its early applications (financial reports, billing, order processing, payroll, and inventory reports), this location in the organization structure was logical. Besides, at that point in time, who else knew enough about data handling to take on such a responsibility?

However, as computer applications have moved beyond clerical tasks, the disadvantages of its organizational location have become more apparent. Staff specialists in data processing seldom have the experience or the perspective to develop systems which provide management with the essential information to make more effective decisions. Yet the real benefits of EDP lie in the increased capacity of management to control and plan the business enterprise—not in cost reductions from computerizing clerical tasks. To compound the problem, management is often unable to define their information needs to EDP specialists. From their past experience, many operating executives perceive management information as being primarily the company's accounting reports and financial statements; i.e., that information they have learned to rely on for control of the firm. Is there something else?

This frequent chasm between the developers and users of information results in reports being generated which are little used by anyone on the one hand, and the absence of needed and valuable management information on the other. Yet another manifestation of this problem is the excessive number, length, and detail of some management reports. To quote D. Ronald Daniel:

"In many organizations the initial reaction to the management information problem is first evidenced by a concern over 'the flood of paperwork.' Eventually, the problem itself is recognized—i.e., the need to define information required for intelligent planning and control of a business."[10]

Defining the information required for intelligent planning and controlling frequently involves careful study and investigation to determine:

[5]Smith, Adam. 1968. The Money Game. Random House, New York, p. 219.
[6]Kelley, William T. 1968. Marketing Intelligence. Staples Press, London, England, p. 6.
[7]Dearden, John. March-April 1965. How to Organize Information Systems. Harvard Business Review.
[8]For example, see Cox, Donald F. and Robert E. Good. May-June 1967. How to Build a Marketing Information System. Harvard Business Review; Daniel, D. Ronald. Sept.-Oct. 1961. Management Information Crisis. Harvard Business Review; and Diebold, John. Sept.-Oct. 1964. ADP—The Still-Sleeping Giant. Harvard Business Review.
[9]Garrity, John T. July-August 1963. Top Management and Computer Profits. Harvard Business Review; and Thurston, Phillip H. Nov.-Dec. 1962. Who Should Control Information Systems? Harvard Business Review.
[10]Daniel, D. Ronald. Sept.-Oct. 1961. Management Information Crisis. Harvard Business Review.

- The responsibilities and authority of each member of the management team, both at present and as projected in the future.
- The essential information needed for satisfactory or improved performance by each member; i.e., what is the really critical information for each executive?

Thus, organizational responsibilities largely determine information needs. And the information needs defined should include all data and intelligence needs—internal and external, quantitative and qualitative, financial and non-financial. While the initial information system may not provide all of the information so defined, the desired scope of the system—at least for a point in time—has been circumscribed.

One additional comment seems warranted concerning firm organization. If the information system of the firm effectively meets the needs of individual executives, this should be reflected in improved performance of their duties, and/or an expansion of their responsibilities due to the greater span of control made possible by pertinent information; i.e., an adjustment should be made in either the criteria for evaluation of executives, or in the breakdown of their responsibilities. To allow management personnel to continue to operate with the same responsibilities and measures of performance after an effective information system is developed will provide little incentive—particularly for those who feel threatened by the system—to use and implement the information provided.

Over time, the impact of a MIS on firm organization will be substantial at all levels. While some fear this impact, Katz *et al.* foresee it freeing management from routine activities, and providing greater opportunities for creative pursuits.[11] Implicit in their position, however, is a rather bleak future for management personnel who refuse or are unable to make such a transition. Since nearly every problem of any significance seems destined to eventually receive computer assistance, a continual reappraisal of firm organization is in order as an information system is developed.

Types of Systems

It is appropriate at this point to recognize that there are a wide variety of information systems—and that a firm's system may be made up of several subsystems. A *system* in this sense refers to the overall design or plan for the inflow of data to the firm, data analysis, and the outflow of information to company management. The execution or implementation of the system design may be via several sub-systems. For example, Dearden suggests that there are three main systems in the typical company: "One concerns the flow of monetary information, one concerns the flow of personnel information, and one concerns the flow of physical goods."[12] All of these are *internal systems* in that they rely mainly on information generated within the firm. At the present time, most are also *control systems* in that they largely provide historical information on what happened yesterday, last week, or last period.

While these may be the three main internal tributaries of information systems, certain external tributaries of information are also important to a complete system. Consumer products marketing firms, for example, may have complex marketing information systems which provide data on competitor behavior, consumer attitudes, market share, general economic conditions, and other relevant factors influencing marketing decisions. Some industry giants undoubtedly have systems for sensing the pulse rate and general posture of the Department of Justice and the Federal Trade Commission in Washington. The frequency, urgency and scope of these various systems (or sub-systems) will obviously vary widely.

Control vs. Planning Systems

The basic difference between these two systems is their time period orientation. Control systems focus on past performance (last week, yesterday or this morning) and evaluate the extent to which previous plans are being carried out. Planning systems focus on future performance and provide information useful in developing plans and strategy for next week, next month, or next year. By its very nature, a planning system attempts to look into the future—often by drawing upon relationships established from the past. A planning system is thus generally dependent upon a sound control system—which has preceded it—and which has generated useful and accurate information for establishing predictable relationships.[13]

A well-designed control system which effectively utilizes exception reporting and incorporates procedures for management to diagnose exceptions can be a powerful aid to management. By promptly calling attention to possible problems and deviations from plans, corrective action can be taken (if necessary) before serious harm has occurred. At the same time, such corrective action is posterior in nature—after the fact.

Even greater benefits accrue as the results of the internal and external control systems are integrated

[11] Katz, Robert, Kenneth Knight, and William Massey. 1966. The Computer in Your Future. **In** The Nature and Scope of Management, by Maneck Wadia, Scott, Foresman & Co., pp. 313 and 314.

[12] Dearden, John. March-April 1965. How to Organize Information Systems. Harvard Business Review.

[13] However, this is not always the case. Forecasts of future sales, for example, may be based upon a survey of potential buyers rather than an analysis of past sales patterns.

(and as predictive relationships are established) to develop an effective planning system. Instead of trying to steer the firm via the rear view mirror, management is now able to direct the firm based upon what they can see of the road ahead. If their visibility is reasonably good, corrections are now possible before the firm is on the shoulder or in the ditch. Since visibility ahead is seldom perfectly clear, the road behind the firm continues to be an important indicator of what lies ahead. To carry this analogy one more step, until the firm is moving in a definite direction and has traveled some distance down their selected road, the visibility ahead is likely to be rather limited. Thus, a certain amount of history (which means time) is required before an effective planning system can be developed.

Logical Pattern of Development

As the foregoing implies, it is usually unwise to attempt to jump too far too quick in systems development. (Of course, the opposite extreme can be equally unwise.) In addition to the need for a data base on which to build a planning system, the importance of management-systems balance also supports a gradual approach to systems development.

The quality of information and the quality of management are definitely related. The former can be upgraded much more rapidly than the latter, which is precisely one of the dangers in systems development. An EDP specialist in a progressive East Coast food chain commented to the authors: "We have the technical capability to give management almost any information they want. The problem is that they really don't know what they need. At first, I developed all types of reports that *I* thought would be useful. Management didn't know what to do with them. Since then, I've backed off—I wait for them to ask for something before I give it to them. Even now, they sometimes ask for certain information, but after we've given it to them for a while, they find it really isn't of that much value." This statement reflects many of the problems thus far discussed—organizational deficiencies, lack of involvement of operating management, and balancing the caliber of information and the quality of management.

The system in this company was primarily a control system. With such a system, the use of *exception reporting* is not only highly useful but often essential to screen the *nuggets* from *all that information*. This, however, depends upon management defining what constitutes an exception, which had not been done in the above firm. The director of grocery operations, for example, might decide that he wants to have a report each morning on those grocery products for which the warehouse has less than 1 day's normal movement on hand. These are the exceptions. Further, in order to *diagnose* the problem, he may ask for information on when these items were re-ordered, when they are expected to be received by the warehouse, and any unusual or explanatory circumstances. The combining of exception reporting with diagnostic information, as in this example, permits much more meaningful use of a control system.

A sound control system provides a steady stream of data which should be accumulated in a *data bank* for future analysis. Such a "storehouse of knowledge" is an essential element for advancing the system for planning purposes. Arnold Amstutz of M.I.T. makes a plea for banking disaggregated detailed information:

"At the heart of every successful information system is a disaggregated data file . . . As new inputs are received, they are maintained along with existing data, rather than replacing or being combined with existing information . . . The existence of a disaggregated data file facilitates system evaluation . . . In the first stages of system development, it is simply impossible to anticipate the direction of later advancement. Aggregate data files may preclude highly profitable system modification. The disaggregated data file provides the flexibility which is the prerequisite of intelligent system evolution."[14]

Applying the rationale of gradual systems development—which evolves from a basic control system to an effective planning system, incorporates a data bank as an essential ingredient, is tailored to management's needs, and advances in step with the updating of management—the following steps in developing a sound information system can be suggested:

1. **Management Commitment**—Commitment by top management to develop a sound information system, and the acceptance of the responsibility for the development of such a system.

2. **Organize with User-Oriented Leadership**—Hiring or assignment of an individual to be in charge of information systems who is *user* oriented, who has top management support, and who can effectively communicate and serve as a liaison between EDP specialists and operating management.

3. **Define Information Needs**—Deliberations to define for each executive the scope of his responsibilities, the critical factors influencing his performance, and the information which would allow him to improve his performance and/or expand his scope of responsibilities. The decision rules for determining exceptions, needed diagnostic information, and timing and form of reports must also be defined.

[14] The Marketing Executive and Management Information Systems. In Science, Technology and Marketing, 1966 Fall Conference Proceedings, American Marketing Association.

4. System Design—The overall system is designed, including its sub-systems and the stages of development. The sources of information, the procedures for processing and analyzing the information, and the flow of information to management and to the data bank are planned.

5. Development and Implementation of a Basic Control System—This system may go through several stages of development to expand the information monitored, and to perfect the data provided to management.

6. Develop Elementary Planning System—Analyses of data from the data bank plus independent studies will provide relationships needed to implement automatic decision systems for tasks such as reordering products and inventory control. Projections of financial and personnel conditions, as well as other information, may also be provided to management.

7. Develop More Sophisticated Planning System—As more complete data are available in the data bank so that more complex relationships can be ascertained, and as management develops its ability to use more sophisticated planning information, systems involving simulation models, linear programming models, and other advanced decision techniques can be developed. The needed relationships for such models will often require additional independent research.

The above steps are not inclusive or infallible. But they suggest one logical pattern of system development which can serve as a guideline.[15] Whether these steps are followed or not, certain essential characteristics of *successful* systems are apparent from the studies which have been conducted. Although most of them have received earlier comment, they provide an appropriate summary for this chapter.

"In the more successful companies, the following patterns have been evident:

- The development of the MIS has been viewed as a management responsibility, including both top management and operating line management.
- Formal organizational lines have been drawn to provide leadership in use of the technique —usually including the appointment of a high-level information coordinator or 'prime contractor' who develops plans and coordinates the efforts of the departments involved.
- The prime contractor reports to the user group, such as the marketing department, rather than to the central systems groups.
- Line managers participate in developing overall specifications for the MIS.
- The sophistication of the system is balanced with that of the managers who use it.
- Systems development typically proceeds in manageable stages, rather than in attempts to develop 'total' systems at once.
- The system is based on a disaggregated data bank which allows managers to retrieve analyses in the form they want without having to specify all their information needs in advance.
- Investments in systems development and operation are justified not on the basis of cost reduction, which is often irrelevant with the MIS, but on an estimate of the system's ability to help managers make more profitable marketing decisions."[16]

CHAPTER II

MANAGEMENT INFORMATION SYSTEMS IN FOOD RETAILING

Food retailing firms have not been immune to many of the problems in the use of computers which were discussed earlier. From the authors' experiences with retail firms, the lack of involvement of operating management, and the tendency of management to rely on *merchandising skill* based upon years of experience are two of the more serious impediments to more complete information systems. In part, the latter may reflect apprehension about the unknown, and a lack of any clear conception of needed information.

In general, systems development in the industry has been initiated and directed by EDP specialists. Although many of these men are highly competent specialists, and have done an excellent job considering their assistance and support, they can seldom develop really effective management information systems alone. Operating management must also be involved.

Most of the systems observed do not have well thought out development plans. The rule rather than the exception seems to be to add another component to the system as someone asks for additional information or analysis. A "blueprint" of the long run information needs of firm management would in most cases be "welcomed with open arms" by EDP personnel so they could plan for the future and begin to build the system in logical stages.

[15]For more comprehensive commentaries on systems development, see Dearden, John. March-April 1965. How to Organize Information Systems. Harvard Business Review; Cox and Good. May-June 1967. How to Build a Marketing Information System. Harvard Business Review; and Evans, Marshall and Lou Hagne. Jan.-Feb. 1962. Master Plan for Information Systems. Harvard Business Review.

[16]Cox, Donald F. and Robert E. Good. May-June 1967. How to Build a Marketing System. Harvard Business Review.

The early applications of EDP in retail firms focused largely on automating clerical tasks. Some firms have moved little beyond this elementary stage. However, many firms have progressed into some form of management control system. These vary widely in their scope and sophistication. A few of the more progressive firms in the industry have moved from control systems into the development of planning systems. In general, the planning systems which exist are still rather rudimentary and deal with only certain segments of the firm's operation. (For example, a re-purchase system for the grocery warehouse.) Almost without exception, the existing systems are internal systems based upon the information flow *within* the firm. External information on the competitive environment has yet to be incorporated to any degree.

Exploratory Efforts

While this attempts to give an indication of the present "state of the arts" of systems development in food retailing, it gives no indication of some of the innovations and experimentations which have been or are taking place. A review of some of these efforts seems in order.

One of the early systems efforts took place at the U. S. Dept. of Agriculture approximately 12 years ago. Armed with a bevy of information on the labor requirements to perform all conceivable tasks in a retail produce department, the Wholesaling and Retailing Research Branch developed a management labor control program. The program (based upon the quantity of each produce item sold and the work methods used) computed the hours of labor which should have been used in a retail produce department during a particular week. Written for the IBM 650 computer, the program proved too cumbersome and detail-oriented to gain practical acceptance.

Since that time, with later generation computers and with computer firms, retail firms, and trade associations actively exploring systems development, several fruitful steps have been taken. In addition to the industry-wide and highly publicized efforts such as COSMOS and the SMI Meat System, individual firms have developed systems in the following areas:

- Schedule store labor based upon the orders received from each department.
- Project sales and gross profit for the meat operation of the total company based upon store orders and the sales plan. Projections are said to come within ½ of 1 percent of the gross profit actually realized.
- Schedule grocery warehouse labor based upon the previous week's sales of key stores.
- Projection of operating results and financial condition, and comparison with budgetary objectives.
- Determine the optimum number and location of distribution centers, using a linear programming transportation model. This provides a long-range master plan to management, indicating which distribution centers are well located, where new ones are needed, and which ones should be eventually closed.
- Analyze the relationship of demographic characteristics of the store neighborhood to store sales, mix, and profitability.
- Market simulation model which indicates the likely success of a new store and the relative standing of existing stores in a given market area.

Although some of these represent intensive treatment of a rather specific problem area, and may not reflect the sophistication present in the total information system of the firm, they nevertheless reflect noteworthy efforts to more effectively utilize EDP for management planning.

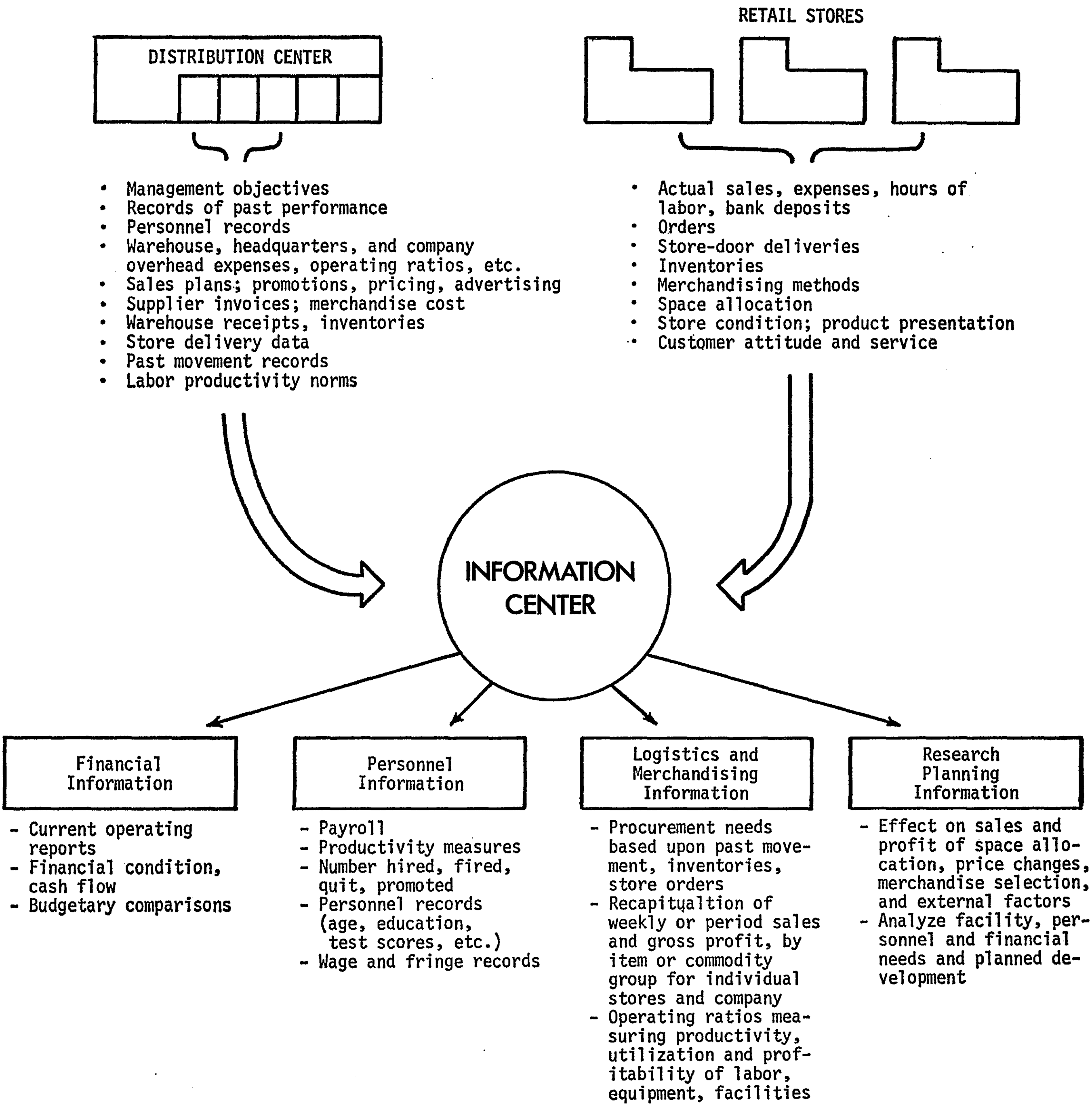
The Scope of Operation of a Retail Food Firm

When one "backs off" to examine the functions performed by a wholesale-retail food firm, they really appear rather simple. A variety of products are purchased from suppliers, warehoused, distributed upon order to retail units, stocked at store level, and finally sold to consumers. The primary concern would seem to be determining how much of each product will be sold during a certain time period. And this in fact is the primary uncertainty food firms face, and the main reason that retail management's task is not quite as simple as it might appear. With 7,000 to 8,000 items, sales prediction becomes a critical, if somewhat cumbersome, element of advance planning. Information on movement of various products becomes one of the central ingredients of a control system. Nearly all of the other resource management decisions of the firm depend upon the essential information—how much of what products are sold (or will be sold), where, and when?

The information inputs for a basic control system are *relatively* easy to obtain. As Figure 2 suggests, the tapping of several bits of information from the distribution center and the retail stores provides the necessary inputs for a wide variety of management reports. The main factors complicating the data inputs are the large number of items handled by the firm, and the differences in the way these items may be handled. The perishable departments in particular create problems in systems development with differences in methods of delivery (warehouse vs. store-door delivery), methods of processing and merchandising at store level, and differences in product loss and conversions. These are not insurmountable problems. However, they pose very real practical problems which may encourage the ignoring of perishable departments in the early stages of systems development.

The internal information flow shown in Figure 2, when supplemented by relevant external information (competitors' actions, weather, pay periods, etc.), provides the base for a rather comprehensive planning system. The accumulation of these data in a data bank allows future analyses to determine some of the relationships needed for a planning system. For instance, what is the impact of paydays, season of the year, and various types of promotions on total dollar sales and the sales of different products? There is promise that such relationships can be ascertained if a bank of reliable data composed of the essential variables from the past is developed.

FIG. 2.—Flow of Information Inputs and Outputs in a Basic Management Information System for a Retail Food Firm.



Developing Retail Information Systems

As suggested in the previous chapter, the logical pattern of system development starts with the definite commitment and support of top management, includes clear definition of the information needs of each member of middle and top management, and builds upon a comprehensive control system which not only provides useful control information, but also deposits information into a data bank.

One comment of caution is warranted concerning retail control systems. If designed so as to bank disaggregated information which may be needed in the future (as it should be), a control system consumes and ruminates a vast quantity of information. One of the most damaging blows which can be dealt an information system is to indiscriminately print-out this information and present it to management. For example, imagine the reaction of the typical meat merchandiser if presented with a detailed print-out of the sales and gross profit by meat item for each of 50 stores. After the initial novelty wears off, he must either learn to look for key indicators, or exceptions, or the entire report is likely to receive little use. Unless such reports press toward exception reporting, his evaluation of information needs may be, "What do I need more information for? I don't have time to use all that I have now!" Hence, with control systems the reporting of exceptions and key indicators should be the immediate objective, with much additional information being banked for future use.

The development of a retail information system is a continuous process, but may be divided into several logical phases for simplification. Figure 3 shows three stages of development following the initial steps of management commitment and identification of information needs. The planning stage, in particular,

FIG. 3.—Three-Stage Development of a Management Information System for Retail Food Firms.

Stage	Capabilities
I Elementary Control System	• Based upon delivery data, summarize units and dollars sold and gross profit expected for individual items, departments, stores, or entire company • Compute productivity ratios for various resources such as labor, inventory investment, store space, etc. • Summarize condition of firm's primary resources (financial, personnel, merchandise, equipment, and stores) • Capture information on company's promotions and on external factors such as competitors' behavior, weather, and paydays
II Up-dated Control System	• Generate more accurate measures of sales and profitability, including incorporation of inventories, cutting tests, labor requirements, and/or space allocation for appropriate departments • Compute hours of labor which "should have been used" for certain departments • Compute marketing loss for perishable departments • Compare profitability of alternative procurement forms and alternative merchandising methods • Summarize evaluations of store operations
III Advanced Control and Planning System	• Develop company, store, department, and item predictive models • Develop warehouse inventory control-re-purchase routine for grocery products • Predict expected sales by item in meat and produce departments, compute optimum procurement (quantity and form), schedule deliveries to stores, and production and labor at store level • Analyze influence of individual components of firm's marketing strategy; determine optimum pricing structure, advertising practice, selection of merchandise, space allocation, and level of service • Project intermediate term sales, profit, cash flow and financial condition. • Project life pattern of individual stores; estimate time of needed remodelings and store closings • Project population movement and growth patterns, changes in market share, and changes in demographic characteristics; define areas of under penetration • Expand the in-flow of information on external factors (such as customer attitude and behavior) and incorporate into planning system

might be further sub-divided. Each stage provides the base for the succeeding stage in this development process—and a certain amount of research and new information is required in moving from one stage to another.

The elementary control system taps into the flow of store delivery information to indicate how much was delivered (or sold if constant inventories are assumed) of various items, in different departments, and in different stores. Extended by cost-retail figures, these data estimate dollar sales and gross profit for various categories. The elementary control system may also calculate typical input-output relationships, such as sales per man hour, tons per man hour, and sales per square foot or linear foot for individual departments.

The state or condition of the firm's main resources (financial, personnel, merchandise, equipment, and store facilities) may also be included in the information flow of this system. Financial reports would normally be included at an early phase of systems development. The condition of the other resources is less frequently included. There would appear to be no great problem, however, in reporting the personnel position of the firm, such as the number of department managers and store managers ready for promotion, the number of key vacancies, etc. The condition of certain types of equipment could also be reported. For example, how many trucks were in operation during the last week, how many were "down," and how many hours were they operated.

The elementary system is a good place to begin to feed in information on external factors such as weather and the action of competition. Such information is hardly necessary when reports are generated for "last week" but can be very valuable at some future date when attempting to determine the impact of external factors.

In moving from the elementary control system of Stage I to the undated control system of Stage II, several relationships and new inputs of data are called for, depending upon the department in question. In the case of the grocery department, variables on space allocation and/or in-store labor are likely candidates for addition in this stage. Of these two, shelf space is likely the most critical variable investment for grocery products.

As several studies have demonstrated, the gross profit per linear foot of display varies widely between products.[17] These studies suggest that increases in profit can be realized from a commodity group or department by: 1) discontinuing some of the very slow movers, and 2) altering space allocation in the direction of equalizing the gross profit per linear foot by item. Thus, the incorporation of space data for at least part of the grocery department in the second stage deserves consideration.

The inclusion of in-store grocery labor data can be considered at several levels of breakdown. Pricing and stocking labor can be charged to individual products to compute direct product profit.[18] Within a particular commodity group, this is likely to be a very minor improvement over gross profit as a profit indicator. Greater variations in labor requirements occur between rather than within commodity groups (baby food vs. paper products, for example). Therefore, it may be more useful to compute the "contribution profit"[19] of the various commodity groups, rather than the direct product profit of individual items.

Still another alternative is to project the total hours required for receiving, pricing, and stocking in the department based upon store orders. While providing no refinement in the profitability measures in the department, such information would be of value in scheduling store labor. Existing labor coefficients such as from the USDA could be used to estimate man-hour requirements, or rather simple work sampling studies could be conducted to establish coefficients for the firm.

For the produce and meat departments, several modifications should be considered in the second stage of the system. The summary of delivery data during the first stage of the system presents several accuracy problems. These include:

- Because of in-store processing, a given item may be merchandised in several ways, each producing a different sales value and gross profit.
- Inventory variance is greater and more critical because of the perishability of these products.
- With in-store processing, the amount of labor required for different products and for different merchandising methods varies consider-

[17]For example, see Crossed, Charles. Oct. 9, 1962. Profits from the Frozen Food Dept. Through Display Space Allocation and Inventory Control. Presentation to 5th Kansas Food Retailers Conference, Kansas State University.

[18]For a guide to the development of direct product profit information, see the McKinsey Manual of Direct Product Profit, National Assoc. of Food Chains, Oct. 1964.

[19]Contribution profit is gross profit less variable costs (costs which increase as sales increase) for a group of products such as a commodity group or department. While variable costs such as trading stamps can be deducted, the relative profitability of different groups is unaffected because of the equal cost to all groups. Labor costs are usually included. Depreciation, which is not a variable cost, may also be included when comparing different departments (meat vs. groceries), but is of questionable value for most management decisions. Shelf space can also be considered as a variable cost in a somewhat different way. As sales increase, shelf space cost may not increase. But as shelf space is varied, sales are likely to be affected. Thus, it is a management controlled variable cost.

ably. Gross profit is thus not an accurate measure of product profitability.

Ideally, then, the second stage development for these departments would involve the addition of the following information:

- Weekly inventories.
- Labor coefficients for performing the various tasks for at least the broad classes of products.
- Cutting or merchandising tests, which provide a basis for computing the retail value and gross profit of alternative methods. The proportion of the product merchandised in different ways for each store must also be fed into the system.

The incorporation of these data permit accurate calculation of product, commodity group, and department sales; gross profit; and direct product or contribution profit for individual stores. When compared with cash register sales, the difference provides a good estimate of the marketing loss in the department. Man hours "that should have been used" in the department during the previous week are also calculated; if accurate, these provide a basis for adjustment of department staffing. A comparison of computed to actual man-hours worked gives an index of efficiency.

Weekly inventories in meat and produce departments, while desirable, present problems of accuracy. In part because store level employees in most firms are not accustomed to taking weekly inventories, have not been sufficiently impressed with the importance of accurate inventories, and are often under time pressure to take the inventory quickly, the accuracy of inventories often leaves much to be desired. Items are recorded under the wrong number, units are recorded as pounds, or vice versa, and "eye ball" estimates may be in serious error. As a result, some products show up with negative sales, while others may show an unexpected spurt in sales. The problems are often sufficient to make one wonder whether inventories add to or detract from movement accuracy.

In view of this, a compromise type of inventory may be the most feasible solution where only the cooler inventory of whole cases and primal cuts is recorded. In addition, unusually large quantities of product which are on special display should be recorded. While this leaves some opportunity for small fluctuations in inventory to go undetected, it does allow compensation for major shifts.

An updated control system for meat and produce departments is much more challenging than one for groceries. Most firms have been rather hesitant in attempting to move beyond elementary control systems for these departments. With the trend toward central packaging of meat and produce, some firms are understandably reluctant to invest the time and resources required to develop up-dated systems. With central packaging of meat and/or produce to retail consumer units, systems development is greatly simplified and becomes similar to the grocery department.

For firms which do not expect to move rapidly into central packaging, an updated system may have a substantial pay-off. Not only does such a system allow more accurate comparisons of the profitability of alternative procurement forms and alternative merchandising methods, better control of in-store labor and marketing loss, and more accurate measures of the effect of advertised specials and external factors, it also removes much of the shroud of mystery from these departments. Top management is provided with a more naked view of the meat and produce operations, and can be more active in evaluation and corrective action than when the departments were concealed in their full attire.

Progressing from Stage II to Stage III is highly dependent upon a rather comprehensive bank of accurate historical data (and a competent research analyst), since several predictive relationships are required. At the same time, Stage III is where the greatest "pay-off" can be expected since it moves the firm from a corrective action "after the fact" position to automatic decision making and advance planning.

The conceptualized characteristics of the advanced control and planning system shown in Figure 3 represent largely virgin territory for the retail food industry. As such, there is no empirical evidence that the necessary predictive relationships can be developed with sufficient accuracy, or that the cost-benefit relationship for the suggested activities will in all cases be favorable. However, some of the exploratory efforts in isolated firms reported earlier lend encouragement, as do the steady advances in computer capacities, the quantity and quality of available information, and analytical methodology. Thus, the question may be more one of *when* than *if* such systems will be developed. Because of the critical role of top and middle management in systems development, a new generation of science-oriented management personnel may be required in many retail firms before much "soil is turned" in Stage III.

The analytical techniques and decision models which may be incorporated in the Stage III system, while difficult to forecast with precision, are likely to include regression and discriminant analysis, linear and non-linear programming, Baysian decision theory, and various simulation models. While these suggest a substantially more sophisticated approach to retail management, it is appropriate to re-emphasize that the development process should be gradual, will be dependent upon the growth of management, and must be launched from a well-developed foundation of data, relationships, and management defined objectives and constraints. Given time, management ability and support, and accurate data on the necessary variables, it seems highly probable that the necessary relationships and decision models suggested for Stage III can be accomplished.

CHAPTER III

BASIC INFORMATION SYSTEMS FOR MEAT AND PRODUCE

The first two chapters have approached management information systems from the broad perspective of where they fit into the firm, how they should be developed, and the most common weaknesses. Chapter II suggested certain logical stages of development for an information system in retail food firms. In this chapter, attention is given to the information systems developed at OARDC for produce and meat operations.

The systems developed at OARDC are Stage II in type (Chapter 2, Figure 3), or up-dated control systems. Because of the previous work done at OARDC and USDA on labor requirements in meat and produce departments, it was possible to develop systems incorporating man-hour coefficients for different products and tasks.

The systems developed are similar in many respects to those presently being used by some retail food firms. The intent of the OARDC effort was to complement, not substitute for, existing systems, and to "tap into" existing information flows and forms. By starting with an information system fairly typical in the industry and increasing its power to provide more accurate and relevant information through several minor yet significant changes and additions, the resulting system should be more easily understood and drawn upon than would have been the case if a new system had been proposed.

System Output

Figures 4, 5, and 6 illustrate the output of the produce and meat systems. Figures 4 and 5 represent the summary tables produced for each store and/or time period. For most purposes, these tables probably contain all of the critical information management needs. Figure 6 illustrates the detailed output available on an optional basis for all items in a department. For problem stores, or for the entire company, such an output may be useful. However, more information is provided than can generally be used on a routine basis. Figure 5 contains several key indicators of a department's operation. Others could be added with small modifications in the programs. One of the goals management should consider is to develop the contents of this table to a point where additional information is needed only for problem situations. Obviously, the accuracy and completeness of this table depend upon the extent to which the options available in the systems are utilized.

In addition to the printed output, punched output is also available on an optional basis. Figure 7 illustrates the content and format of card output. This allows for the development of a card data bank for future analysis and use as an alternative to disc or tape storage.

Flexibility of Systems

A significant feature of the OARDC systems is their high degree of flexibility. The systems provide many options which, when fully utilized, result in far more accurate and complete management information than is typically available with existing systems. However, none, some, or all of these options may be used. In their simplest form, with no options exercised, the systems provide a summary of the sales and gross margins of items and product groups, for individual stores or for an entire company, based upon delivery data. The time period involved depends upon the period covered by the delivery data read in.

Options available to modify the systems include:

- Adjusting delivery data with weekly inventories, which also allows computation of inventory turn-over figures.
- Inclusion of labor coefficients by item or by class so that direct product profit and total labor needs are calculated.
- Inclusion of cutting tests (meat) or alternative merchandising methods (produce) to adjust the sales and gross margin for different products in accord with the merchandising practices of individual stores.
- Inclusion of shrinkage allowances.
- A comparision of actual and computed results, by reading in data on actual department sales, man-hours, wages and supplies.

In addition, other minor options are also available (such as printing weekly features).

While the systems were developed with a definite emphasis on meeting the needs of operating management, they were also developed with concern for EDP personnel and equipment efficiency. Four stores required 1½ to 2½ minutes of run time on the IBM 7094, depending on the number of options exercised. The data input decks are organized in accord with the number of changes required from week to week or from store to store. To avoid card sorting, a binary search routine allows most of the store data to be read in without ordering by item number.

FIG. 4.—Summary Table by Classes from OARDC Meat Program, Store 20—Week 4, for Week Ending Jan. 23, 1971.

	Lb. Sold	Inv. Turn	Sales Value	Dollar Gr. Mg.	Percent Gr. Mg.	Direct Class Profit	Percent DCP	Percent of Department Totals: Lb. Sold	Sales	Gross Margin	DCP
Beef Miscellaneous	201	NI	149.72	16.72	11.17	13.57	9.06	0.63	0.67	0.43	0.46
Beef Ground	1698	1.3	789.36	18.18	2.30	—59.11	—7.49	5.33	3.54	0.47	—1.99
Offal Pork and Beef	349	NI	189.05	73.31	38.77	49.91	26.40	1.10	0.85	1.88	1.68
Veal and Lamb	940	NI	683.58	101.61	14.86	35.50	5.19	2.95	3.07	2.61	1.20
Pork Fresh	886	NI	660.93	165.16	24.99	138.80	21.00	2.78	2.96	4.24	4.68
Sausage and Bacon	1760	NI	1541.27	309.24	20.06	294.05	19.08	5.52	6.91	7.93	9.91
Smoked Meat	918	NI	831.45	186.12	22.38	158.78	19.10	2.88	3.73	4.77	5.35
Sliced Luncheon and Wieners	1242	NI	1182.97	352.19	29.77	340.11	28.75	3.90	5.31	9.03	11.47
Fresh Poultry	1569	NI	668.99	116.08	17.35	102.05	15.25	4.92	3.00	2.98	3.44
Canned	82	NI	88.84	30.76	34.62	25.66	28.88	0.26	0.40	0.79	0.87
Lard	168	NI	40.08	6.94	17.32	1.31	3.27	0.53	0.18	0.18	0.04
Delicatessen	2471	NI	2301.79	603.52	26.22	506.17	21.99	7.75	10.32	15.48	17.07
Bulk Luncheon	407	NI	277.59	92.76	33.42	76.78	27.66	1.28	1.25	2.38	2.59
Frozen Poultry	3542	NI	2611.78	106.73	4.09	80.85	3.10	11.11	11.72	2.74	2.73
Beef Round	4688	5.3	3063.61	461.77	15.07	294.48	9.61	14.71	13.74	11.84	9.93
Beef Chuck	3803	13.6	1919.01	312.55	16.29	200.99	10.47	11.93	8.61	8.02	6.78
Beef Rib	1184	8.0	867.75	109.99	12.68	58.20	6.71	3.72	3.89	2.82	1.96
Beef Loin	2025	5.8	1620.00	162.00	10.00	75.11	4.64	6.35	7.27	4.15	2.53
Pork Loin	2702	3.1	1935.44	433.85	22.42	344.94	17.82	8.48	8.68	11.13	11.63
Poultry Parts	1233	NI	870.99	239.62	27.51	277.62	26.13	3.87	3.91	6.15	7.67
Department Totals	31,868		22,294.20	3899.10	17.49	2965.77	13.30	100.00	100.00	100.00	100.00

LIST OF FEATURES FOR WEEK -- 4

XXX	HYGRADES SLI. BACON	LB.	$0.79
XXX	BNLS	LB.	$0.89
XXX	CENTER RIB CHOPS	LB.	$0.89
XX	WH. CHICKENS DELI.	LB.	$0.99
XX	GROUND ROUND	LB.	$0.89
XX	T-BONE STEAK	LB.	$1.29
XX	SIRLOIN TIP BNLS. ROAST	LB.	$0.89
XX	FR. PICNIC ROAST	LB.	$0.49
XX	PORK STEAKS	LB.	$0.69
XX	PORK LOIN ROAST RIB END	LB.	$0.59
XX	WH. STEWS	LB.	$0.29
XX	ROASTING CHICKENS FR.	LB.	$0.49
XX	P-O-T CHICKENS 3 DRUM, 3 TH, 3 BR	LB.	$0.69
X	SLAB BACON	LB.	$0.69
X	SMO. PICNICS	LB.	$0.49
X	RATH WIENERS	LB.	$0.65
X	SLI. SMO. MEATS ECKRICH	3/	$1.00
XXX	ROUND STEAK	LB.	$0.89
XXX	PORK CHOPS FIRST CUTS	LB.	$0.59
XXX	WH. FRYERS	LB.	$0.39
XX	FR. MACARONI SALAD DELI.	LB.	$0.49
XX	SIRLOIN STEAK	LB.	$1.09
XX	CUBE STEAK	LB.	$0.99
XX	PORTERHOUSE STEAK	LB.	$1.09
XX	FR. SPARE RIBS 3-5 LB. AV.	LB.	$0.59
XX	SPARE RIBS COUNTRY STYLE	LB.	$0.59
XX	WH. BNLS. PICNIC ROAST	LB.	$0.79
XX	FROZ. DUCKLINGS	LB.	$0.49
XX	CHICKEN LIVERS	LB.	$0.89
X	HYGRADE TH. SLI. BACON	2 LB.	$1.69
X	HYGRADE SMO. PORK CHOPS	LB.	$0.99
X	SMO. HAM STEAKS	LB.	$1.19
X	KAHN BOLOGNA 8 OZ.	EA.	$0.59
X	CORNED BEEF ROUND OR BRISKET	LB.	$0.79

FIG. 5.—Summary Table from OARDC Meat Program, Store 20—Week 4, for Week Ending Jan. 23, 1971.

	Computed	Adjusted Computed	Actual	Actual Minus Adjusted Computed	Percent Variation
Sales	22,294.20	22,071.26	22,176.52	105.26	0.47
Gross Margin	3,899.10	3,676.16	3,781.42	105.26	2.86
Percent G. M.	17.49	16.66	17.05	0.39	

LABOR RESULTS

	Hours	Total Hours	Wages
Direct Labor			
Processing	96.5		
Traying	34.5		
Packaging	34.1		
Pricing	22.7		
Stocking	61.1	248.9	$ 933.33
Indirect Labor			
Reconditioning	7.1		
Receiving	11.8		
Clean-up	30.1		
Supervision	12.0		
Administration	13.9		
Setup and Miscellaneous	19.5		
Customer Service	34.9	129.3	$ 484.88
Personal and Delay	54.1	54.1	$ 202.88
Totals		432.3	$1621.09

Total Supplies $225.00

Labor Summary

	Adjusted Computed	Actual	Percent Variation
Sales	22,071.26	22,176.52	0.47
Gross Margin	3,676.16	3,781.42	2.86
Direct Class Profit	1,830.07	1,881.34	2.80
Percent DCP	8.29	8.48	
Total Hours	432.3	445.5	—3.05
Total Wages	1,621.09	1,675.08	
Sales per Man Hour	51.06	49.78	
Gross Margin per Man Hour	8.50	8.49	
DCP per Man Hour	4.23	4.22	
Payroll as Percent of Sales	7.34	7.55	
Supplies as Percent of Sales	1.02	1.01	

FIG. 6.—Illustration of Detailed Print-out from OARDC Meat Program.

6 PORK FRESH	LB. SOLD	INV TURN	RETAIL PRICE	SALES VALUE	DOLL. GR MG	PCT GR MG	LABOR COST	D.CLASS PROFIT	PCT. DCP	PERCENT OF CLASS TOTALS SALES	GR MG
BNLS PK LOINS 20=	60.	5.0	1.5100	90.60	30.60	33.77				22.52	30.04
4-8= BOST BUTTS 53=	129.	1.2	0.6650	85.78	24.59	28.66				21.32	24.14
4-8= PICNICS FRESH 55=	84.	NI	0.4650	39.06	7.31	18.71				9.71	7.17
DECK BRT PICNIC 015=	34.	NI	0.7500	25.50	2.72	10.67				6.34	2.67
SPARE RIBS 3/0 030=	156.	2.1	0.7125	111.15	25.43	22.88				27.62	24.96
SPARE RIBS 3-5=	89.	2.0	0.5650	50.28	11.21	22.30				12.50	11.01
TOTAL	552.	2.2		402.38	101.86	25.31	15.92	85.94	21.36	100.00	100.00

7 SAUS + BACON	LB. SOLD	INV TURN	RETAIL PRICE	SALES VALUE	DOLL. GR MG	PCT GR MG	LABOR COST	D.CLASS PROFIT	PCT. DCP	PERCENT OF CLASS TOTALS SALES	GR MG
DECK SAUS HOT -59 1=	32.	1.1	0.6900	22.08	7.47	33.84				2.88	3.48
WALDORF SAUS PLAIN 001=	17.	0.7	0.9500	16.15	4.29	26.54				2.10	1.99
KAHN SMOKEY TREAT 12 OZ	5.	2.0	1.3200	6.93	1.85	26.67				0.90	0.86
KAHN COV BRATURST 001=	-4.	-2.0	0.9900	-3.96	-0.80	20.22				-0.52	-0.37
B EVANS REG SAUS LB	185.	2.3	0.9500	175.75	44.40	25.26				22.89	20.66
WEBB REG SAUS - 85 LB	65.	4.8	0.7900	51.35	14.20	27.65				6.69	6.61
WEBB HOT SAUS -1.69 2=	26.	2.4	0.7850	20.41	5.58	27.32				2.66	2.59
FISCHER BF SAUSAGE 1 LB	10.	1.4	0.5900	5.90	1.79	30.37				0.77	0.83
PLSH KIELBASI DECK 010=	12.	0.6	0.8400	10.08	3.13	31.08				1.31	1.46
HYG OLD FAV BAC 1= -79	204.	4.9	0.8500	173.40	54.90	31.66				22.58	25.54
HYG BAC TH SLI 2= -169	26.	2.4	0.9950	25.87	8.45	32.67				3.37	3.93
SLI BF BACON	-5.	-1.3	1.1200	-5.88	-1.63	27.68				-0.77	-0.76
DECK SLI BACON - 89 1	54.	3.6	0.9900	53.46	18.59	34.77				6.96	8.65
KAHNS BACON SLI 1-2=	2.	2.0	1.3000	2.60	0.97	37.26				0.34	0.45
KAHNS BACON SLI 001=	208.	2.4	0.9900	205.92	49.82	24.19				26.82	23.18
CANADIAN BACON LC ENDS	6.	2.0	1.2900	7.74	1.96	25.28				1.01	0.91
TOTAL	843.	2.4		767.80	214.96	28.00	4.72	210.24	27.38	100.00	100.00

Relatively few firms may wish to adopt the OARDC systems intact. Perhaps the more realistic use of these systems is to provide ideas to firm personnel on ways that existing systems can be modified and improved.

In large part, the way that these systems are viewed by management personnel depends upon the value placed on the information they make available. The authors believe, for example, that in produce and meat operations, direct product profit is a much more meaningful measure of profitability than gross profits. Unfortunately, empirical tests to measure the costs and benefits of this or other types of information are not available. Hopefully, some of the retail pioneers in management information systems will shed some light on such cost-benefit questions as a result of their explorations.

The options built into the OARDC systems and resultant information capacity reflect two primary considerations: 1) current information needs of management as perceived by the authors and cooperating firm personnel, and 2) the long-run information needs of companies assuming continued expansion of information systems to more fully utilize computer capabilities and decision assisting procedures.

Some of the more advanced decision models which draw upon the basic information system are decribed in the following chapter. This discussion may provide yet a different perspective of the role and need for information in retail food firms.

FIG. 7.—Example of Punched Output Available from OARDC Systems.

ITEM NR.	ST. NR.	WK. NR.			LB. SOLD	RETAIL PRICE	SALES VALUE	GR. MG.	CL	LB. DEL.
1010	9	1	RIBS		296.	0.7000	207.20	56.24	1	246.
	9	1	BEEF RIBS		296.		207.20	56.24	1	
1020	9	1	TRIMMED LOINS		100.	0.7640	76.40	16.40	2	150.
1030	9	1	SHORT LOINS		170.	1.1000	187.00	34.00	2	170.
	9	1	BEEF LOINS		270.		263.40	50.40	2	
1040	9	1	ROUNDS	SP	250.	0.6250	156.25	36.25	3	200.
	9	1	BEEF ROUNDS		250.		156.25	36.25	3	
1050	9	1	CHUCKS		160.	0.4275	68.40	18.00	4	180.
	9	1	BEEF CHUCKS		160.		68.40	18.00	4	
1060	9	1	BEEF KIDNEYS		15.	0.2700	4.05	2.25	5	10.
1070	9	1	BEEF LIVER		31.	0.5550	17.20	7.15	5	31.
1080	9	1	BEEF HEARTS		20.	0.4500	9.00	2.41	5	10.
	9	1	BEEF MISC.		66.		30.25	11.82	5	
2105	9	1	PORK LOINS 8-14 LB.	SP	277.	0.6080	168.42	29.20	6	277.
2109	9	1	PORK LOINS 12-16 LB.	SP	10.	0.6080	6.08	1.07	6	10.
	9	1	PORK LOINS		287.		174.50	30.26	6	
2150	9	1	HARVEST HAMS 10-12 LB.		115.	0.8900	102.35	20.70	7	90.
2175	9	1	HARVEST BNLS. HAMS		124.	0.9500	117.80	20.87	7	149.
	9	1	SMOKED PORK		239.		220.15	41.57	7	
3010	9	1	KAHN BACON 1 LB.	SP	27.	0.9900	26.73	6.48	8	24.
3020	9	1	KAHN WIENERS 1 LB.		26.	0.6900	17.94	4.19	8	36.
	9	1	BACON AND WIENERS		53.		44.67	10.67	8	
3109	9	1	WHOLE FRYERS	SP	370.	0.2900	107.30	16.50	9	330.
	9	1	POULTRY		370.		107.30	16.50	9	
3150	9	1	OYSTERS STD. 8 OZ.		6.	1.3800	8.28	2.54	10	6.
3170	9	1	OYSTERS STD. 12 OZ.		15.	0.9900	14.85	2.54	10	10.
	9	1	MISC. MEATS		21.		23.13	5.09	10	

NOTE: Cards with no item number, retail price, or pounds delivered are class totals.

CHAPTER IV

EXTENSIONS BEYOND A BASIC INFORMATION SYSTEM[20]

To this point, emphasis has been placed on the rationale and procedures for developing a basic information system for the retail firm. In many ways, that is the most difficult and least exciting aspect of MIS development. Once a sound basic system has been developed, however, the groundwork is laid to move into more exciting and sophisticated modifications of information systems.

The possibilities for extensions beyond the basic system are nearly limitless for one endowed with imagination and future vision. In this chapter, no attempt is made to list or discuss the many possible extensions, but rather the following three specific illustrations are discussed:

1. Procurement.
2. Forecasting.
3. Profit maximization.

The three case examples all depend upon a data source which can be most efficiently and accurately provided by a basic information system such as described in the previous chapter.

Because they may be viewed by many as representing the real "pay-off" stages of information systems, and are certainly more sophisticated and prestigious, firms may be tempted to jump directly to the development of such models. Experience in developing and working with these models suggests that such a move is likely to be premature. Not only is the data development problem a serious impediment, but the lack of acceptance by key management personnel of the models may limit their usefulness if such personnel are not gradually "developed" along with the information system.

Product Procurement

Some procurement-inventory control models are already in use by the retail food industry. These are largely applicable to products where no processing is done at the warehouse or retail store, and to products whose prices are relatively stable. On such products, the procurement decisions are relatively simple and straightforward.

Such models are not appropriate for procurement of most meat and produce items. Procurement is more complicated with these items since they frequently can be purchased in more than one form to satisfy a given retail requirement, the quality varies from time to time, and relative prices as well as absolute prices change over time (steer carcasses vs. heifer carcasses, for example).

A company's procurement objectives are generally to minimize procurement costs subject to certain constraints. While an individual buyer can hand calculate the least cost method of buying individual products, he generally cannot afford the time to continually compare the various alternatives on all products purchased. Thus, habit and rules of thumb are used for many procurement decisions.

Because of the number of variables affecting optimum procurement patterns, meat and produce purchasing represents an interesting opportunity for computer employment to assist retail buyers. The greater the number of alternatives in buying, the greater the potential contribution of a computerized procurement model. In those cases where retail stores buy directly from meat packers, or where a wholesaler central buying program exists without central warehousing and distribution, the alternative sources of supply are limited to those packers providing store-door delivery in the market area. Further, the individual stores largely determine the grade, weight, and form of the products purchased. In such cases, a procurement model cannot likely be justified.

In considering chain organizations, however, particularly where central warehousing and breaking exists, the practical potential of a procurement model is much greater. The essential functions of a linear programming type procurement model are shown in Figure 8.

In this model, comparisions can be continually made between alternative procurement methods. For example, cutting tests and current retail prices allow computation and comparison of the value of choice heifer and steer carcasses, of different weight cattle, of different weight pork loins and hams, and of different yield grades of beef (Choice 2 vs. 3 vs. 4, etc.). Where quality or consumer preference differences exist, these can be brought into the model either by estimating a value difference, or by building in certain restraints on the products purchased. In choosing between 10-12 lb. and 14-16 lb. pork loins, for example, the cutting tests allow an economic comparison, but ignore quality differences. If the meat personnel of a company or their customers prefer the finer texture of the lighter weight pork loins, this may be entered as a restraint on the model. For example, regardless of price, the company may decide that at least 50 percent of their pork loins should be 10-12 lb. in weight. An alternative is to estimate the magnitude of this preference in cents per pound. In this approach, the value of the loins computed from cut-

[20] The contents of this chapter draw heavily on two unpublished masters theses: Wickline, James. 1965. The Use of Linear Programming in Studying Retail Meat Department Management. The Ohio State Univ.; and Bay, Lloyd T. 1970. Weekly Sales Forecasting for Major Items in Supermarket Meat Departments. The Ohio State Univ.

ting tests and retail prices is adjusted to reflect the quality or preference difference.

The problem of joint costing warrants comment. When sides or quarters are considered for purchase, some people would argue that the cost of the primals broken out of these cuts must be estimated if they are to be compared with the purchase price of packer rounds, loins, etc. One method of doing this is to compute 4 or 6-week moving averages of the ratio of values of the various primals. For example, a 4-week moving average of wholesale prices for primals from the hind quarter might indicate the following:

Loin	1.00
Round	.75
Flank	.25

Using the price of loin as a benchmark, (X), round is .75X and flank .25X. If a hind quarter is expected to yield 45 percent round, 43 percent loin, and 12 percent flank, then the cost of the primals from a hind quarter costing .73 per pound can be estimated as follows:

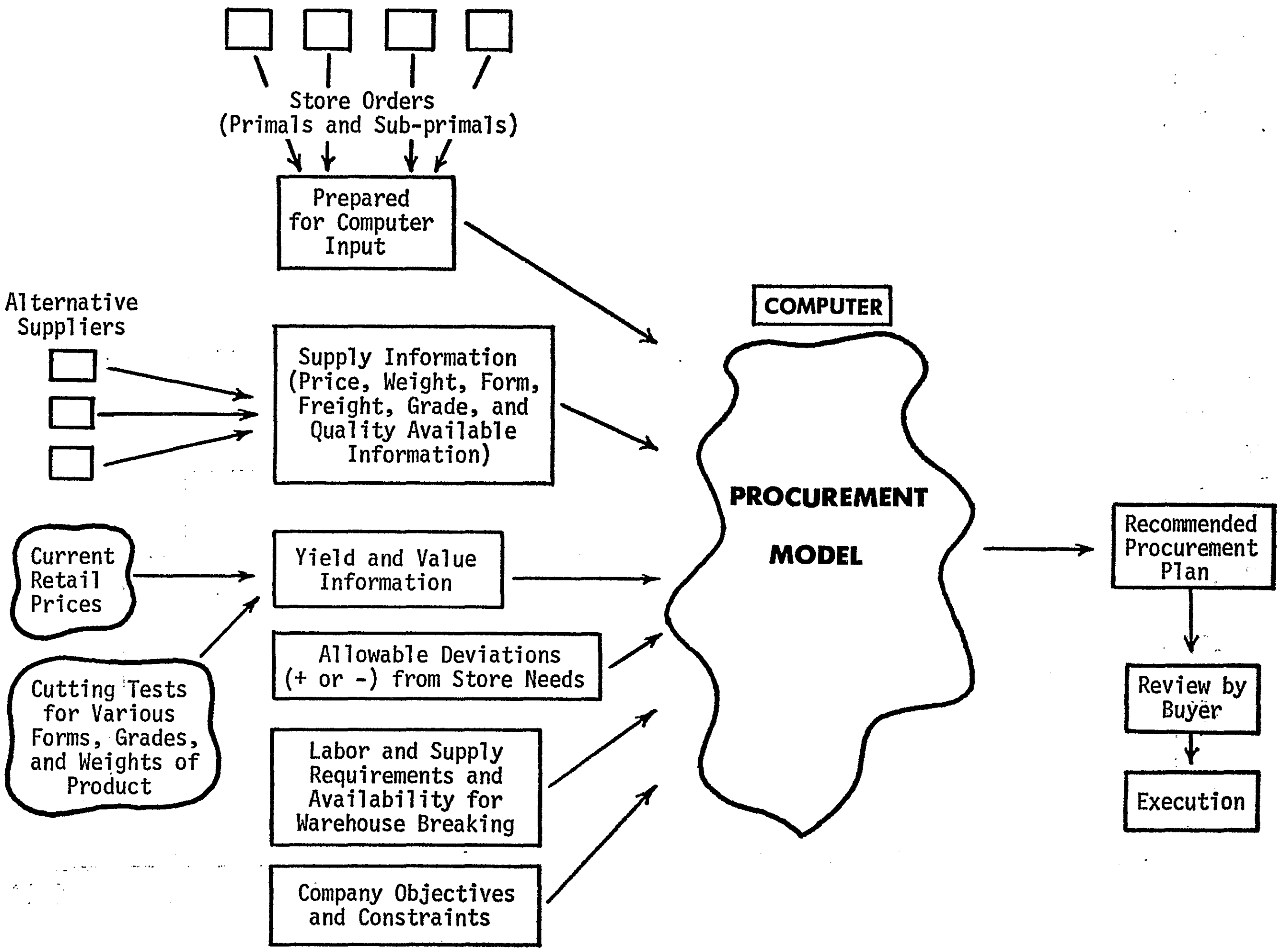
Pounds/ cwt.	Price Index		
Loin—43	X	=	43.00X
Round—45	.75X	=	33.75X
Flank—12	.25X	=	3.00X
			79.75X = 73.00

$$X = \frac{73.00}{79.75} = .915$$

In this case, the appropriate cost of the loin cut out of a .73 hind quarter is .915; the round would be costed at three-fourths of this, or .686, and the flank at .229. In making such cost estimates, care should be taken that the sum of the parts approximates the whole, or that appropriate adjustments are made if the market prices of *trimmed* primals are being used to estimate the cost of *untrimmed* primals.

While the foregoing provides an appropriate method of calculating the cost of primals cut from quarters, the authors contend that such calculations are largely of value in determining the profitability of different primals, *not* in making procurement decisions.

FIG.8.—Flow Plan of Procurement System.



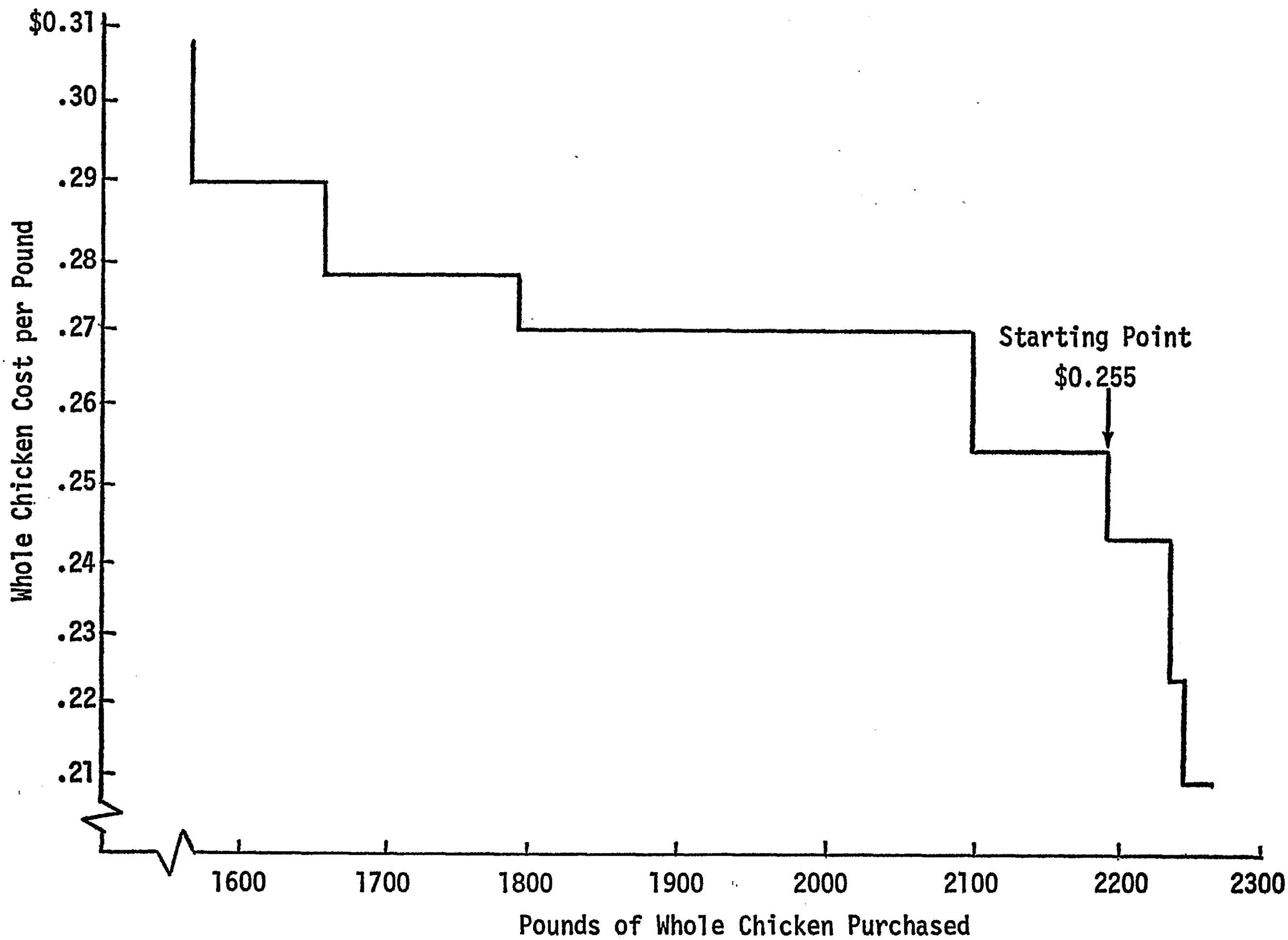
The latter will largely hinge on comparing the cost of a quarter with the composite cost of the primals going into that quarter. If, for example, hind quarters are less expensive than the summed cost of a round, loin, and flank, the quarter is the appropriate form to buy these products—at least until the needs of the slowest selling primal have been satisfied.

Consider, for example, the situation where 125 loins and flanks and 150 rounds are needed. If prices are similar to those in the previous example, the main question would be how to meet the need for 25 rounds. This could be met by buying hinds and carrying over the loins and flanks to the following week, or by buying 25 packer rounds to supplement the 125 hind quarters.

In order to allow but still control this type of procurement possibility, allowable deviations from store requirements can be incorporated into the model. For a relatively perishable product like fresh fryers, the allowable range may be quite narrow—2 to 3 percent, for example. For a product like beef rounds, the positive part of the range might be much greater. Definite costs are involved when purchases deviate either way from store requirements. Under-procurement results in lost sales and some customer dissatisfaction. Surplus purchases, on the other hand, result in a certain amount of shrinkage on many fresh products, tieing up of capital, and some added labor cost due to increased trimming and handling. These costs must be charged to purchase deviations if the optimum solution is to be accurate.

The cost of breaking labor and supplies may be arbitrarily charged to the primals on the basis of the relative value of the primals. How this is handled depends some on the firm's warehousing and breaking operation. If employees involved in breaking are guaranteed a minimum number of hours of work (which is normally the case), the company is committed in the short-run to a certain minimum wage expenditure whether or not the hours of labor are actually needed or used. Thus, until the minimum number of hours has been worked, the opportunity cost of breaking and packaging primals and sub-primals is *zero*. This provision can be built into the model by

FIG. 9.—Pounds of Whole Chicken Purchased in Model by Store 1 to Meet Sales Needs for Various Types of Chicken, as Price of Whole Chickens Varies, All Other Prices Being Constant.



setting a minimum number of hours of labor which must be worked. The maximum hours available and the point at which overtime pay begins are other relevant aspects of the labor component of the model.

Cost Ranging: Experience with the model may suggest that it need not be used every week for all products, although it may actually be the most efficient system for processing store orders. Given the inputs indicated in Figure 8, cost ranging can be employed to determine where changes will occur in the optimum procurement solution. These new decision points can be used as rules of thumb without continually re-running the model as long as there are no significant changes in other variables in the model. For example, given the optimum procurement method for beef, it could be instructive to find out how sensitive this optimum is to changes in product costs or in labor costs. Unfortunately, an example of cost ranging for beef is not readily available. Figure 9 illustrates the results of cost ranging on fresh fryers in which the cost of whole fryers is allowed to fluctuate. With all other factors constant (the cost of fryer parts, wages, etc.), each step indicates a new optimum procurement solution.

The foregoing has described some of the salient features of a linear programming procurement model. While the model is conceptually rather straightforward, its operational development involves a substantial number of coefficients and several management decisions. While the procurement model has been discussed separately, it can be tied to the other two models which are discussed later. In point of fact, the procurement model is an important part of the profit maximization model.

Forecasting

The development of procedures for accurate short-term forecasting of product sales, while holding the potential for considerable pay-off, has received relatively little attention in food retailing. In part, this may be due to the perceived difficulty of forecasting accurately. Perhaps a strong need is not sensed. Yet most studies of perishable departments indicate that weekend inventories far exceed desirable levels, resulting in unnecessary product and quality losses.

In this section, comments are made on a few forecasting efforts with which the authors are familiar, and the meat forecasting models developed at OARDC are reviewed.

Much of the forecasting work which has been done in the retail food industry has focused on warehouse, division, or total chain sales or movement. One company has been reasonably accurate in predicting division sales during particular weeks, using the current sales trends for the division plus the sales pattern experienced during an earlier year when holidays and weekends fell on the same dates. This approach frequently involves drawing on data 6 or 7 years old. It does suggest a rather strong influence from paydays and holiday purchasing.

Another company has found that warehouse movement (and hence labor requirements) can be predicted with reasonable accuracy by using the previous week's grocery sales in several key stores. This information is used to schedule warehouse employees with greater accuracy.

Faculty members at VPI developed a forecasting model for the warehouse movement of ten produce items. Using 4 years of weekly data, distributive lag models were developed using prices, features, temperature, precipitation, and sales trends as independent variables. Except for one product, the predictive models explained 80 to 90 percent of the variation in weekly quantities sold. While some of the models' weaknesses limit direct application, the results are encouraging.[21]

In addition to the above, some companies or organizations affiliated with the food industry have employed simple moving average types of forecasting procedures. For relatively stable or gradually changing products, this approach may be of acceptable accuracy.

The forecasting work conducted at OARDC focused on forecasting the sales of wholesale meat cuts for individual stores on a week-to-week basis. While this work is reported more completely elsewhere, the highlights are presented here.[22]

Forecasting efforts have been made with two different firms during the past 6 years. While the first effort was somewhat less successful than the later effort, the circumstances and procedures were sufficiently different to warrant comment on both efforts.

Firm A, 1965-66: In this case, the movement of various wholesale meat cuts in eight stores of the same chain was studied over a 30-week period. The intensity of weekly features was measured by: 1) the square inches of newspaper space devoted to cuts from the different primals, 2) the amount of price reduction (in cents) for the retail cut most drastically reduced (from each wholesale cut), and 3) the *average* price reduction for all retail cuts making up the primal or wholesale cut. The meat features of the two primary competitors of the firm were measured in a similar way.

Other promotional activities of the study firm (e.g., pages of grocery ads, number of free stamps,

[21]Johnson, J. and D. Long. May 1970. Forecasting Warehouse Produce Movement. Agri. Res. Serv., USDA, Washington, D.C., ARS 52-44.

[22]Interested parties may obtain a copy of this bulletin when it is available by requesting from the senior author.

etc.) and seasonal variables were also included in the analysis. No variable measuring the occurrence of paydays was included.

Multiple linear regression analysis was used to analyze the data for all eight stores, with dummy variables employed to sort out individual store influences.

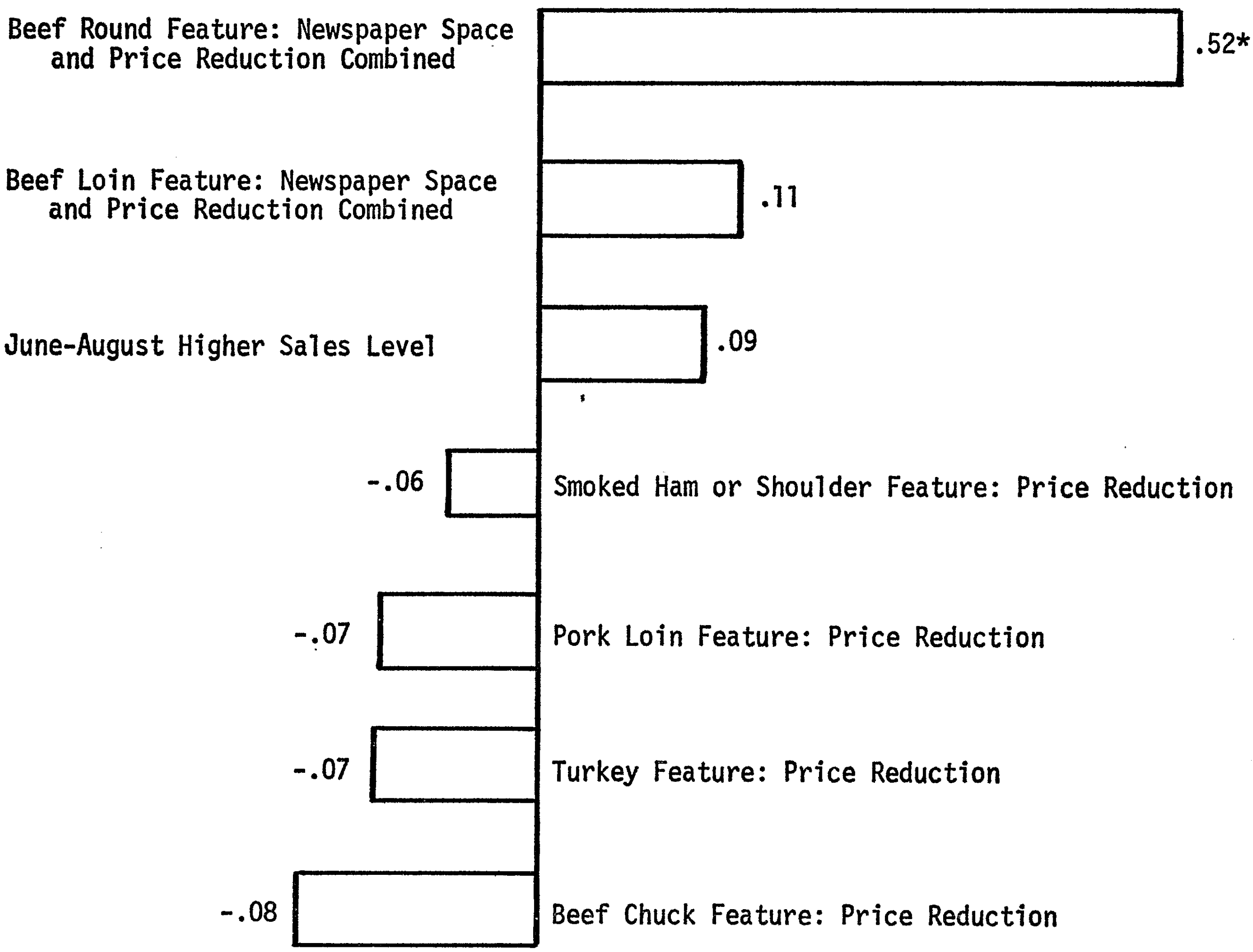
Except for beef plate, the regression models explained 70 to 85 percent of the variation in the movement of the primals studied. The variables which had significant effects on beef round and chicken tonnages are shown in Figures 10 and 11. Adjustments have been made for individual store influences and thus the results shown represent the relationships across all eight stores.

The *average price reduction* for the different wholesale cuts was the variable most frequently entering the equations. A combination variable (newspaper space x deepest price cut) was also important in some models. Seasonal variables entered only in the beef round and "all beef" models.[23]

While this analysis met with reasonable success, it was also somewhat disappointing considering the large number of variables included. To actually be used for predictive purposes, the results were considered inadequate.

[23]Variables measuring the promotional efforts of competitors were found to cause illogical sign changes when they entered some of the models. To avoid this, these variables were kept out of the first computer run, and were used in a second run to explain the residuals of the first runs. Some relationships were discovered. However, in many cases there seemed no plausible explanation for the relationships found. Thus, these are not included in the above discussion of results.

FIG. 10.—Beef Round Tonnage. Ranking of Significant Influences on Weekly Sales Changes in Eight Stores, Columbus, Ohio, During 30 Weeks, 1964.



*Standard partial regression coefficient, which may be compared with other coefficients for relative importance of these variables on sales. The coefficient represents the ratio of the average observed change in sales to the average observed change in linage, price, etc.

In retrospect, at least four possible explanations come to mind.

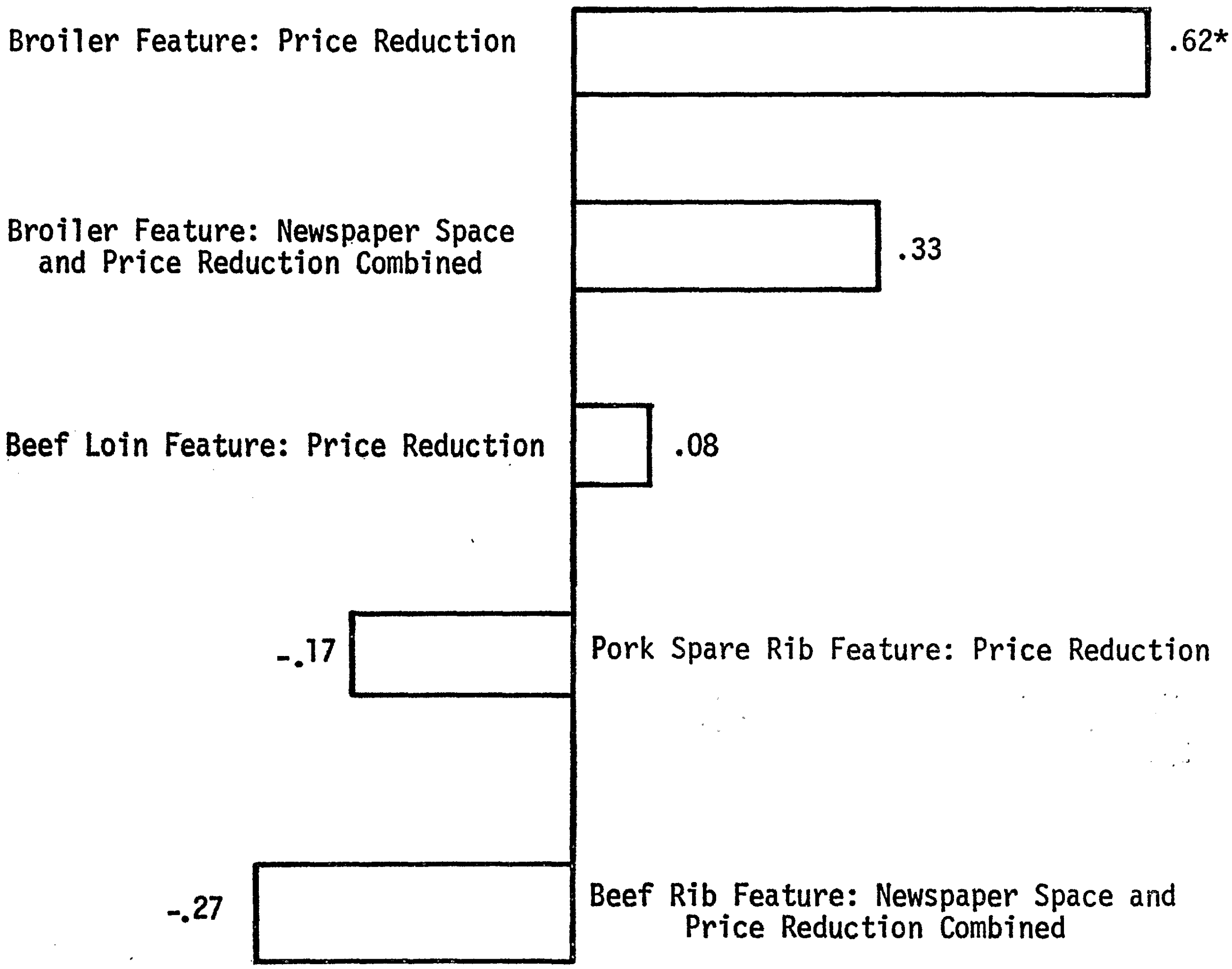
1. The firm followed the practice of featuring a few strongly reduced meat items each week. The gyrations in product movement which result from this practice may be more difficult to measure and predict than where a more moderate featuring strategy is followed.

2. At the time of the study, the firm had a central warehousing and distribution operation but no central breaking. The retail departments were thus receiving beef product in primals and quarters and, because of the featuring policies, frequently had to adjust merchandising methods to sell all of the product received. Given the need, most meat department managers can influence the sales mix in their department by manipulating some of the in-store factors influencing sales, such as the amount and location of space, point of sale material, closeness of trim, cutting methods, etc. No attempt was made in the experiment to control in-store variables.

3. The method of analysis may have concealed important store differences. By analyzing all eight stores together, the slope of the regression lines in the different stores were assumed to be the same (the dummy variables adjusted for different Y intercepts, but not for different slopes). It now appears that the slope of the regression lines may vary significantly from one store to another. (Consider, for example, the difference in response one might expect from a low income vs. a high income store to a steak sale or a pork roast sale.)

4. The influence of paydays was ignored.

FIG. 11.—Fresh Chicken Tonnage. Ranking of Significant Influences on Weekly Sales Changes in Eight Stores, Columbus, Ohio, During 30 Weeks, 1964.



*Standard partial regression coefficient, which may be compared with other coefficients for relative importance of these variables on sales. The coefficient represents the ratio of the average observed change in sales to the average observed change in linage, price, etc.

Firm B, 1969-70: The second forecasting effort met with somewhat greater success, even though fewer variables were included. The firm studied in this case generally featured many items with moderate price reductions, was doing some central breaking, and attempted to avoid manipulation of sales by meat department personnel through fixed space allocations in the display case and by holding the department manager accountable for the gross margin which could typically be produced from the sales mix of the department, rather than the average gross margin of all stores. The *expected* sales and gross margins were calculated by the computer for each department, based on delivery data.

The biggest problem encountered in the second forecasting effort was that of accurate store inventories. Where a firm centrally distributes meat and has a basic information system, information on products delivered to each store, retail prices, costs, and features are very easy to obtain with excellent accuracy. From a practical standpoint, accurate store inventories are probably the biggest obstacle to the development of accurate product movement information.

One of the other areas where inaccuracies can creep in is the variation in individual store cutting methods, or the relative use of alternative cutting methods (e.g., bone-in vs. boneless). The OARDC information system for meats allows compensation for these factors. In the data used for forecasting, however, such adjustments were not made. A standardized cutting test conducted at the warehouse was used to estimate the retail value of a primal cut for all stores.

Weekly data on meat product movement in two stores over a 52-week period were obtained and summarized for analysis. Subsequently, 20 weeks of data were eliminated because of holiday weeks or data inaccuracies.

Multiple linear stepwise regression analysis was used to test the fit of ten predictive models of the following general type:

$$\text{Pds. A} = b_0 + b_1 \text{ Pr. A} + b_i \text{ Pr. O}_i + b_7 \text{ Gr.} + b_8 \text{ Temp.} + b_g \text{ Rain} + b_j \text{ S} + b_k \text{ Pay 1} + b_L \text{ Pay 2} + b_m \text{ Adv.}$$

where:

Pds. A	=	Pounds sold of item A
Pr. A	=	Price of item A
Pr. O	=	Price variables of five other items studied besides item A
Gr.	=	Growth variable
Temp.	=	Average weekly temperature
Rain	=	Average weekly rainfall days
S	=	A set of three dummy variables which allows for a seasonal variation in item sales
Pay 1	=	Nearness to payday variable Set I—a set of three dummy variables which allows for a change in the level of the demand curve by week of the month.
Pay 2	=	Nearness to payday variable Set II—a set of three dummy variables which allows for a change in the slope of the demand curve by week of the month.
Adv.	=	Nine variables (not entered as a set) which indicate the number of retail cuts advertised for nine different meat categories.

The models were tested on six fresh meat products in each of two stores. The six wholesale cuts were beef round, beef loin, beef chuck, beef rib, pork loin, and fresh fryers. The percentage of the variation in pounds sold which were explained by the models ranged from 55 percent for beef rib to more than 90 percent for fresh fryers.

The variables which proved significant varied some from product to product. For the same products, the appropriate models for the two stores were similar, although not identical. The only variable which showed no significant relationship to any of the product-store runs was advertising. This may be due to the relatively small changes which occurred in the meat ads of the cooperating chain from week to week. Many of the same items appeared in the ads week after week with slight changes in prices or cuts. Under these circumstances, either advertising had no significant influence on sales, or the variable used to indicate advertising did not effectively discriminate between changes in emphasis.

The variables which proved significant in ten of the product-store runs are shown in Table 1. The strong influence of paydays was somewhat surprising, with one of the payday variables entering all but one of these equations.

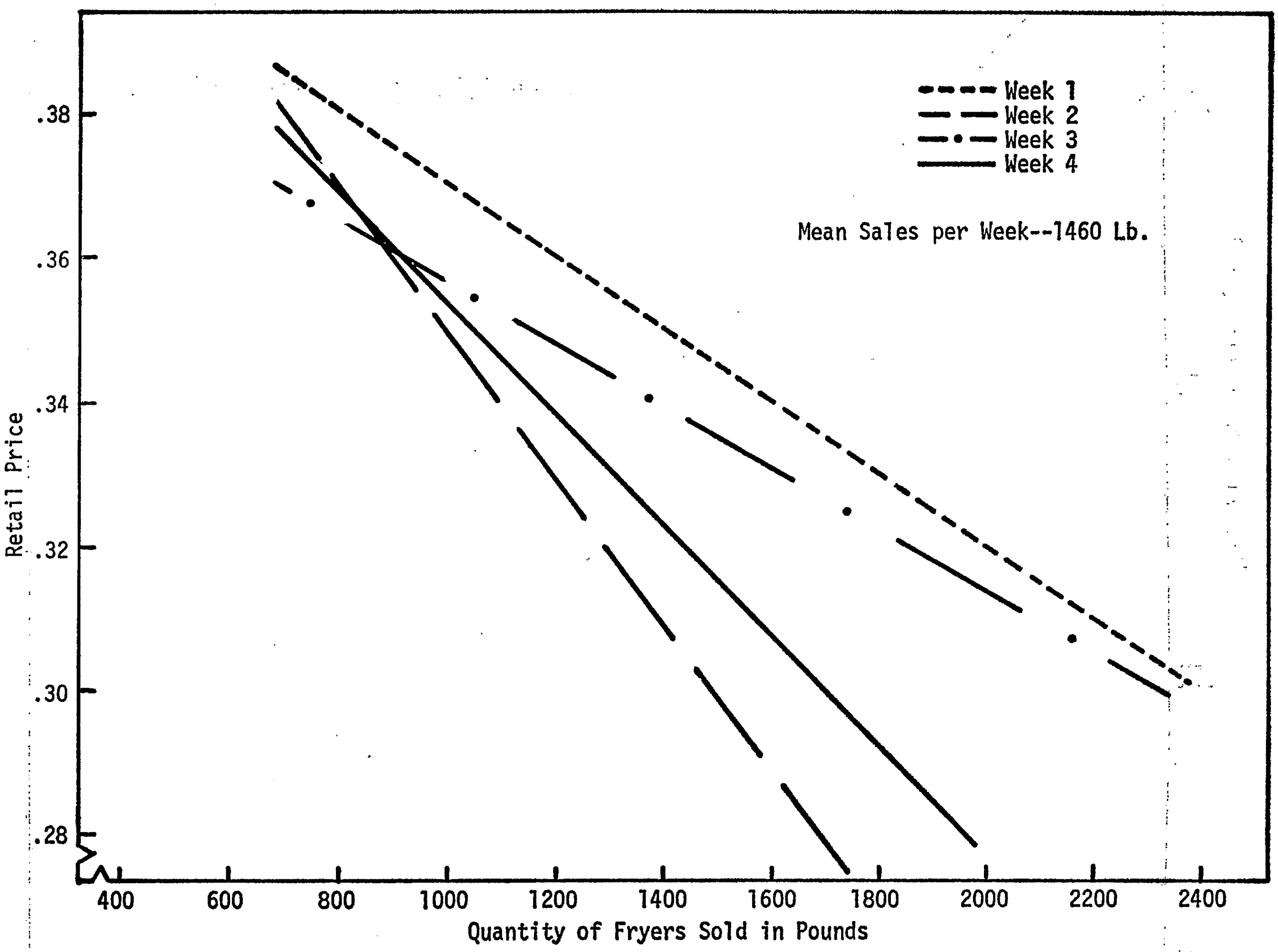
Figures 12 and 13 illustrate the varying impact of paydays on different products. If it is assumed that weeks 1 and 3 are the two most important pay weeks, in that order, then responses to price reductions are least for beef round but greatest for fryers during pay weeks.

One explanation for this pattern, which was true not only for beef round but for most other beef products, is that during periods of high cash availability (weeks 1 and 3), consumers allow their preference patterns to govern their purchases to a greater extent than when cash is in shorter supply, when conserving expenditures may be the dominant concern. Thus, during weeks 1 and 3, consumer demand for beef (their preferred product) tends to be relatively inelas-

TABLE 1.—Usage and Rank Order of Importance of Variables in the Models Selected.

	Beef Round		Beef Chuck		Beef Loin		Pork Loin		Fryers	
	Store		Store		Store		Store		Store	
Independent Variables	A	B	A	B	A	B	A	B	A	B
Price of Round	3	3	1	2			5	4		
Price of Chuck			3	7			6	2		
Price of Rib		5					1	5		
Price of Loin		7	4	4	5	1			2	4
Price of Pork Loin		6				3	3	6		
Price of Fryers		9		6					1	3
Growth	5	8		5		4	2			
Temperature	4	4		3	4				4	5
Season Set					3	2	4	1		
Payday I Set	1	1	2		2			3	3	2
Payday II Set	2	2		1	1		7			1

FIG. 12.—Price-Quantity Relationships for Fryers by Week of the Month, Store B.

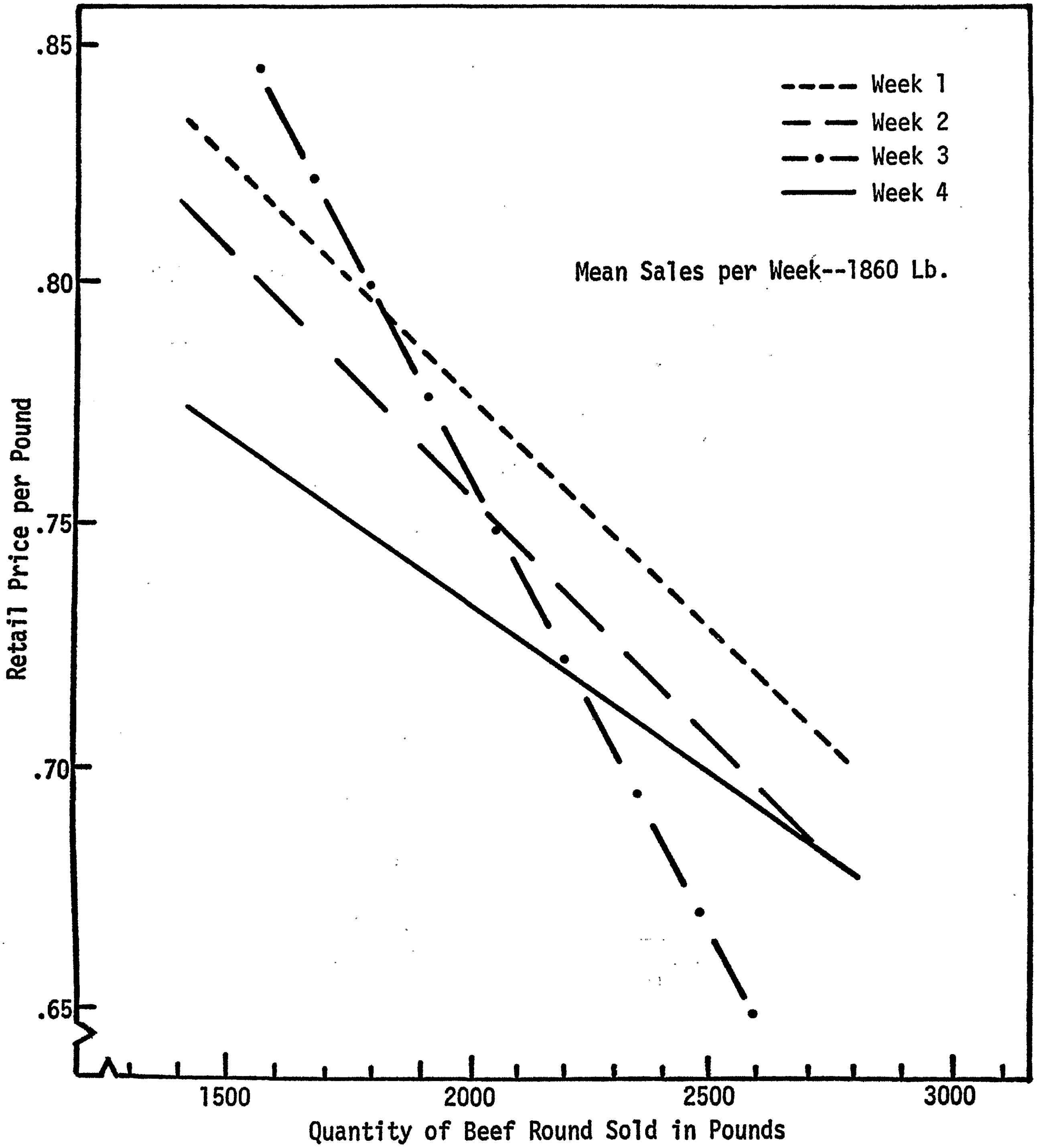


tic. Likewise, during weeks 2 and 4, the demand for fryers is less responsive to price changes, since this is an economizing product for many consumers who will buy fryers whether or not featured. During weeks 2 and 4, the quantity of beef which consumers feel they can afford seems to depend more heavily on whether these products are reduced in price.

The predictive capabilities of these models were found to be acceptable during many weeks, but subject to relatively large errors periodically (Figure 14). This suggests that some sales influencing factors were present which were not included or not adequately measured in the models.

It may well be that predictive models used in

FIG. 13.—Price-Quantity Relationships for Beef Round by Week of the Month, Store B.



conjunction with the judgment of individual meat department managers may provide more accurate results than reliance on either alone. This combination was not tested in the OARDC project.

Other variables could be included in predictive models in addition to the ones discussed here. The independent variables included in these models were intentionally limited to those which an individual company would realistically be able to estimate. Such things as the meat features of competitors, while possibly influencing sales, are generally not available to a firm in time to be useful in predicting sales a week in advance.

The development of short-term forecasting models, while still in the exploratory stages, holds sufficient promise for success to justify additional efforts. If a system for obtaining more accurate inventories can be obtained, the problem of developing accurate movement information is not great where a basic information system exists. Since accurate forecasting models *may* require many weeks of data to establish reliable relationships, they depend heavily on a data bank which has preserved the essential information over a significant time period.

Once accurate predictive models have been developed (assuming that added refinements will make this possible), an important barrier to scientific planning and decision making in retail firms will have been overcome.

Profit Maximization

The third example of possible extensions beyond a basic MIS which has been selected for comment is that of profit maximization for the meat operation. The procurement model previously discussed is one component of a more general profit maximizing model. Both can be most appropriately developed as linear programming models in which a wide variety of alternatives and restraints can be considered simultaneously.

The general scope of the profit maximizing problem is shown in Figures 15 and 16. The total model need not be developed all at one time. Also, the number of alternatives considered in the model can be gradually increased as the model is used. One might start, for example, by assuming that the sales mix of a firm is relatively inflexible, and the methods of product disassembly are fixed. In this case, the model would determine the optimum methods of pro-

FIG. 14.—Actual and Predicted Sales of Beef Round in One Ohio Supermarket, 32 Weeks.

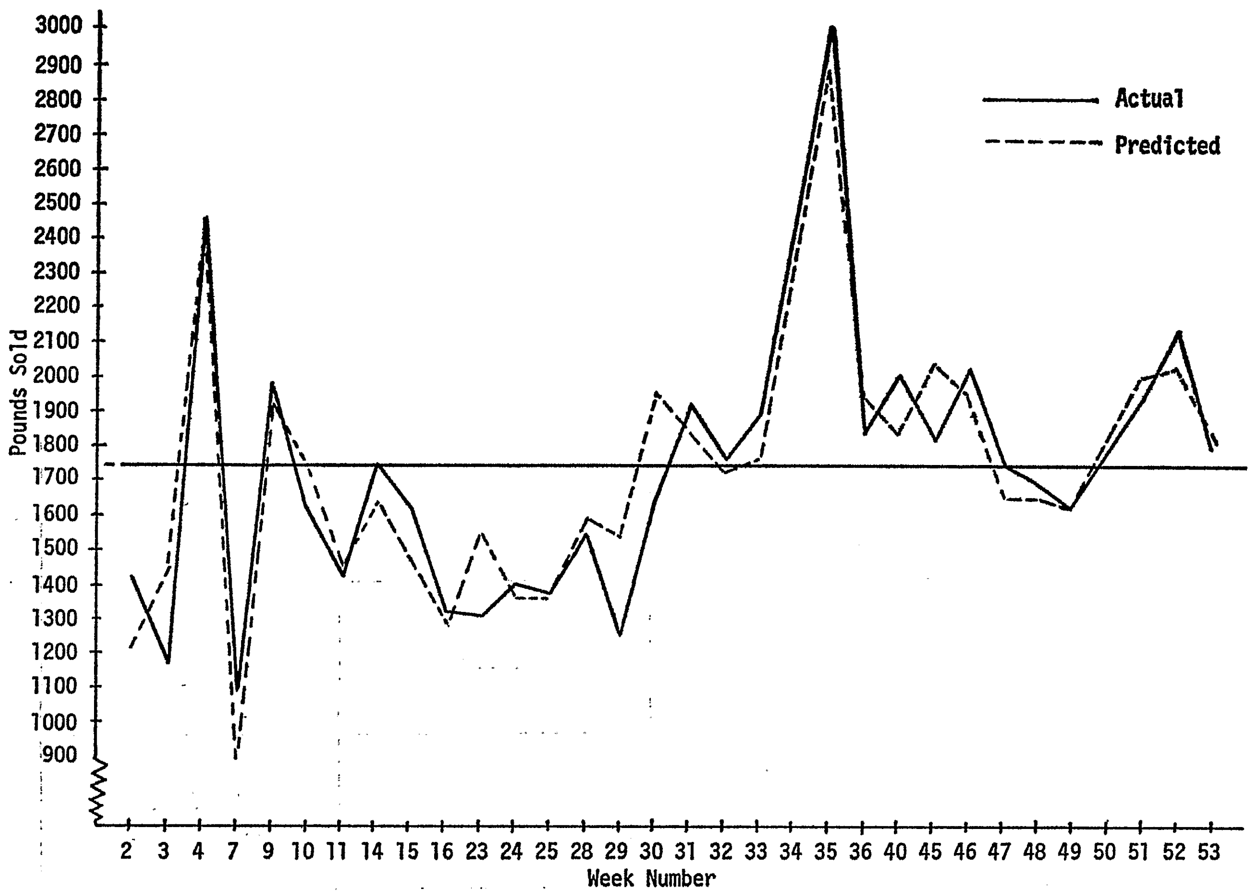


FIG. 15.—Production Flow Diagram and Flow of Information to Alternative Methods of Purchasing, Processing, Merchandising, and Disassembling Products.

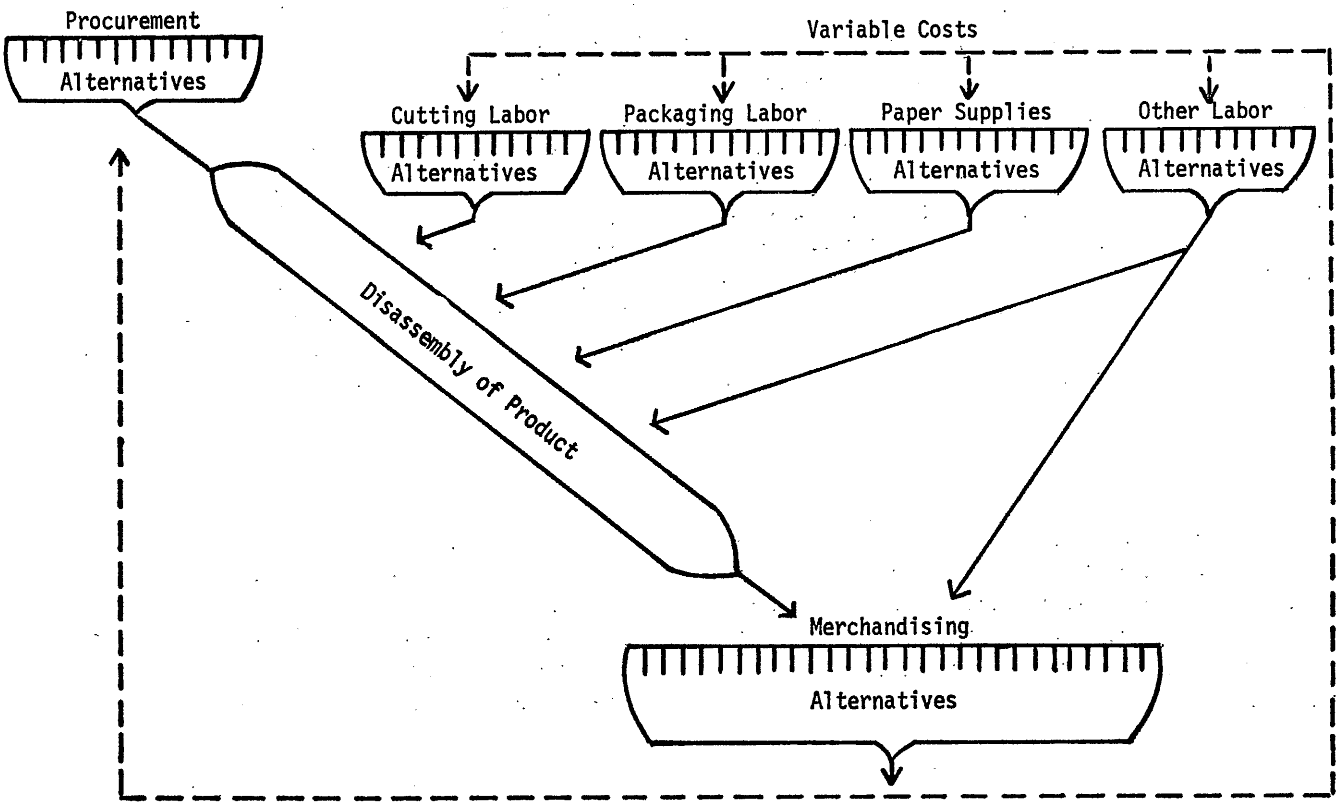
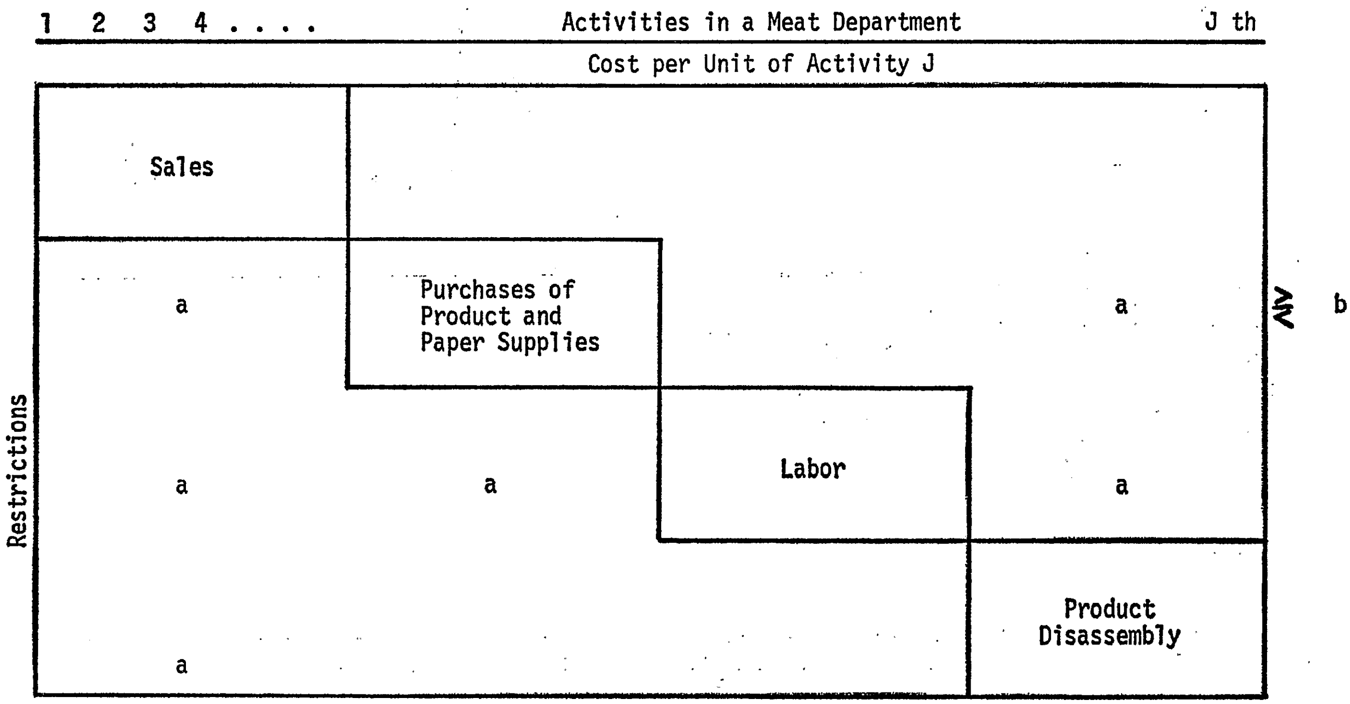


FIG. 16.—The Four Operating Areas in a Meat Department and How They Fit into the Linear Programming Model.



curement, considering labor costs and restraints. The model might further be limited initially by considering only certain procurement alternatives (only steer beef from certain suppliers, for example). Thus, while the development of such a model might seem overwhelming at the outset, it can be accomplished one step at a time.

The intent of this discussion is not to provide an exhaustive discourse on the development of a profit maximizing model, but rather to provide some insights to management on its nature and potential. Perhaps this can best be done by commenting briefly on the characteristics of a linear programming model, and each of the four components of the model identified in Figure 16.

General Characteristics of the Model: A problem must have three general attributes in order to be appropriate for a linear programming model.[24] These are:

1. A specific objective is definable.
2. There are alternative ways of achieving the objective.
3. A scarcity of resources or other restricting forces exists.

In the case of a profit maximizing model for a retail meat operation, the most appropriate objective is to maximize the dollar *contribution to overhead* (CTO = Retail Sales — Cost of Goods Sold — Variable Expenses). While the expenses deducted from gross margin vary among users, there is strong logic to deducting only those expenses which truly vary with the level or composition of sales. The variable portion of labor and supply inputs are the primary variable expenses in most meat operations and are the ones used in the MIS models discussed in the previous chapter.

The matter of alternative methods of achieving the objective warrants careful examination, for a model like the one discussed here can only be economically justified if a large number of alternatives exist. If a relatively few number of alternatives are *actually* available to a decision maker, the basic management information system plus some hand calculations are probably the more practical method of choosing between alternatives.

While a retail meat operation certainly seems to entail a sufficient number of alternatives to justify considering linear programming, in practice this may not be the case. If in fact management holds strong convictions about the type of products to be purchased, the methods of cutting and merchandising, and the use of labor in the department, then the real alternatives available may be rather limited.

This may be particulary true in considering those alternatives which are judged to carry long-run influence on customer image or loyalty. Such things as the quality of meats, the effect of meat specials on total store traffic and sales, the in-store appearance of the meat case, and the pricing strategy within the department are variables which may be largely imponderable in their total effects. Given the uncertainties of handling a different grade or weight of an important product like beef, management will often choose a known and satisfactory course of action, recognizing that it may not be the route of maximum profit. On the other hand, as more information is developed to remove the uncertainties of various alternatives, the relevant alternatives may be increased.

Sales: The sales component of the model contains price and quantity information for the various meat products sold. Until some type of forecasting model is developed which identifies price-quantity relationships, the data used may be relatively fixed and not allow changes in price other than for those items being specialed. The quantities to be sold at the given prices may be allowed to vary some, due to in-store merchandising emphasis. For example, a manager may estimate that at "current" prices, he will sell 1200-1250 lb. of beef round, 625-650 lb. of beef loin, 1400-1500 lb. of beef chuck, and 225-250 lb. each of beef rib and plate, depending on the location and quantity of space given the various products, but only 3900 lb. of beef in total.

The computer will choose the optimum sales quantity for the various primals, within the ranges given, to maximize the CTO dollars from beef.

The above approach is often the most practical approach when the model is first developed. If and when information is developed on the responsiveness of various cuts to price changes, advertising, quantity of display space, and other factors affecting sales, these can be incorporated into the sales component to increase the comprehensiveness of the model results.

Procurement: Since most of the earlier comments about the procurement model apply in this context where procurement is one component of a larger model, only a few points are added here. In this setting, the procurement component includes those alternative sources from which the optimum sales mix (chosen by the model) can be satisfied.

Table 2 presents the optimum sales and procurement methods for two stores, developed by a linear programming model at OARDC. While these results pertain to store operations a few years ago when central breaking was rare, they illustrate the output of a

[24] There are also the five standard assumptions of any linear programming model of linearity, divisibility, additivity, finiteness, and single value expected. Most textbooks on linear programming provide a discussion of these basic assumptions.

TABLE 2.—The Need for Beef by Primal Product and the Method of Purchasing Selected by the Model to Fulfill These Needs.

Product	Store 1 Sales Needs	Store 1 Purchases	Store 2 Sales Needs	Store 2 Purchases
Beef				
Cattle		3236*		754*
Hindquarters		50		502
Forequarters		0		0
Round	1245	255	629	105
Loin	665	0	352	0
Plate	287	3	304	237
Rib	244	0	57	0
Chuck	1452	359	698	442
Total	3893	3893	2040	2040

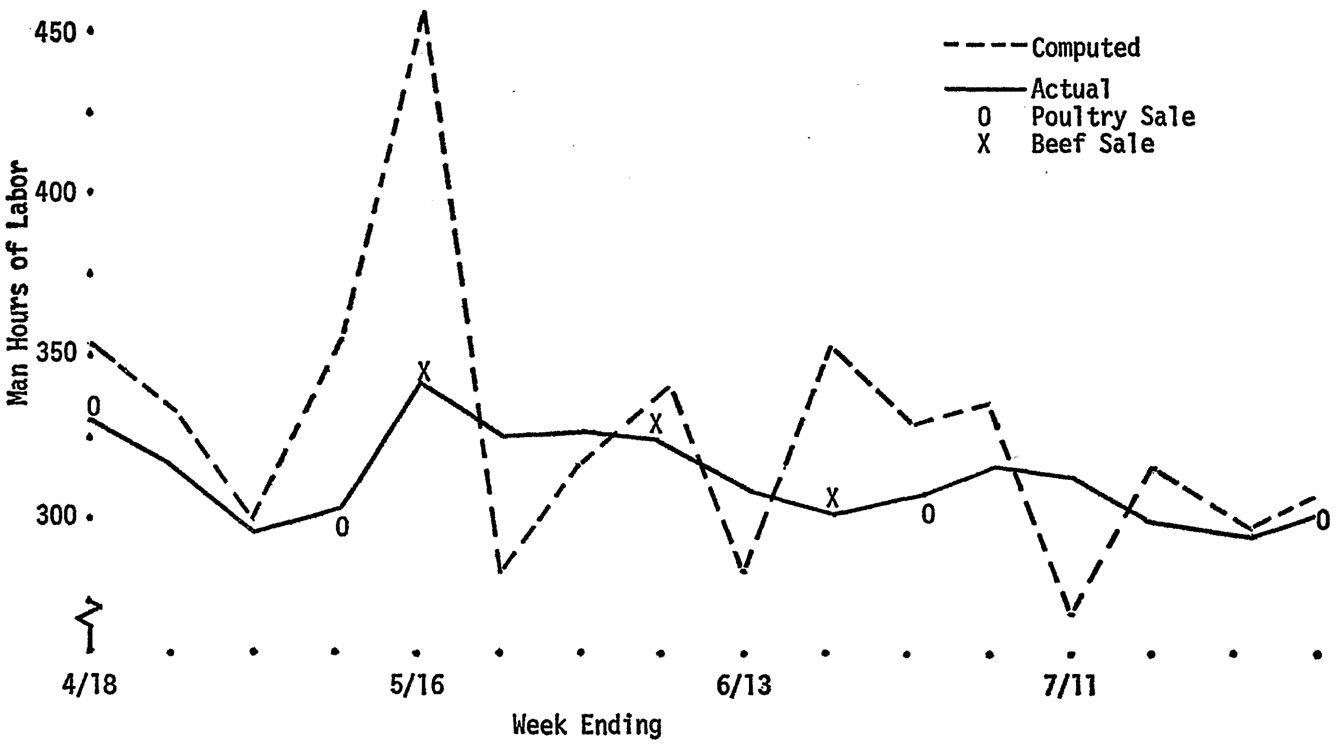
*Whole cattle without breaking trim.
Source: Wickline, James. 1965. The Use of Linear Programming in Studying Retail Meat Department Management. Unpublished Masters Thesis, The Ohio State University, p. 38.

TABLE 3.—Time-Use Restrictions by Type of Employee and Type of Processing.

Type of Employee	Available Hours		Percent of Time by Type of Processing					
			Cutting		Packaging		Other	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Manager	40	55	—	30	—	16	61	79
Cutters	80	80	49	63	5	—	31	42
(Overtime)	0	30						
Wrappers	130	150	—	—	60	76	24	40
(Overtime)	0	15						
Clean-up Boy	10	30	—	33	—	33	—	100

Source: Wickline, James. 1965. The Use of Linear Programming in Studying Retail Meat Department Management. Unpublished Masters Thesis, The Ohio State University.

FIG. 17.—Computed and Actual Man Hours per Week for Store 1.



profit maximizing model, whether used for individual store operations or for the total company.

Labor: The labor component of the model provides information on the hours of different types and costs of labor available to the operation, the minimum and maximum constraints, and the necessary coefficients to compute labor needs in the department. Minimums and maximums are needed both for the number of hours available from cutters, wrappers, etc., and for the proportion of time that each type of employee could spend doing different tasks (cutting, packaging, displaying, ordering, clean-up etc.). Unless these types of restrictions are incorporated into the model, the clean-up person may be scheduled for tasks which only the manager can do. The labor constraints used by one firm are shown in Table 3.

The cost of labor generally is readily available. The relevant costs for this type of problem are those varying with the hours worked. Thus those fringe benefits which are tied to total wages should be included as part of the cost of labor, while those fixed in cost whether the employee works 10 hours or 30 hours should be excluded.

The labor requirements to perform different tasks should be handled in a similar manner. That is, the variable labor required to process 100 lb., more or less, of a product is generally the relevant consideration for all products except those the firm is willing to drop completely, or those available both in unprocessed and in consumer packaged forms (ice-pack vs. processor packaged fryers, for example).[25] Obviously, the range of decisions which the model is allowed to make largely determines the costs which are relevant.

Given accurate labor coefficients, the labor component of the model determines the optimum number of hours of different types of labor to accomplish the optimum sales mix. The basic control system discussed in the previous chapter also computes labor requirements, but on an ex post basis for the sales mix actually realized. A comparison of computed vs. actual man hours may identify some important shortcomings in the scheduling of labor. Figure 17 indicates that in an example department where the featuring strategy involved a few deep-cut specials, the labor actually used was not sufficiently flexible to match the mercurial labor needs.

[25]For a more complete discussion of the relationship between labor requirements and the workload in meat departments, and of the rationale for defining the relevant costs for different types of decisions, see Marion, Ott, and Walker. 1966. Meat Department Labor Requirements. OARDC, Res. Bull. 982.

Product Disassembly: The product disassembly component of the model contains data on the alternative cutting and merchandising methods for those products cut and/or packaged by the firm. Pork loins, for example, may be cut and merchandised in several different combinations of roasts/chops and boneless cuts/bone-in cuts. For each cutting method the firm wishes to consider, a cutting test with selling prices would be needed.

In addition, minimum and maximum restraints for each method are usually necessary to keep the optimum solution feasible. Beef round, for example, might be merchandised in only two ways—regular (bone-in) and seamed (boneless). The relevant range of sales for the primal cut (round) is established by the sales component of the model. Within this range, the optimum pounds to be sold seamed and regular are determined by the contribution to overhead from each method and the restriction placed in the model. One store, for example, might estimate a feasible range in sales for seamed round of 10 to 20 percent of total round sales, while for another store a range of 50 to 60 percent of total round sales may be realistic. Initially, the ranges for different merchandising methods may be established by department manager judgment. Some experimentation may allow further refinement of these restraints.

Summary

In this chapter, three examples of extensions beyond a basic MIS have been discussed in rather cursory fashion. The mechanics of developing linear programming or predictive models have received little attention since these are available from many other sources. Instead, attention was directed more at the benefits and unique problems in applying these models to retail meat operations.

Unfortunately, no estimates are available of the cost-benefit ratios for such models. Thus, a decision to develop these or similar models involves a "leap in faith."

Some important indirect benefits of such models also must be weighed. In the process of developing such models, a great deal will be learned about the various factors affecting retail operations; further, these influences must be quantified to the extent possible. Thus, the models serve as catalysts to a comprehensive examination of the interrelationships in a retail operation. The increased understanding of the business which results can have strong pay-offs to management, irregardless of the direct benefits from the models themselves.

CHAPTER V

CONCLUDING COMMENTS

All firms have some type of management information system—whether it is a barrel in which invoices and sales receipts are "filed" or periodic reports prepared with the help of a computer. In this publication, a philosophy of information is proposed which positions the acquisition, sorting, and distribution of information as a *core function* of future firms—a function that will occur not on an ad hoc basis, but rather on a planned systematic, "information hunter" basis.

Past experience with management information systems indicates that the involvement of line management in the development of these systems is essential if the information developed is to be relevant for management needs, and to assure their support and continued commitment. The process of pushing each executive to define the minimum pieces of information which are critical to his performance can be a valuable growth experience by itself, if done creatively.

Besides the basic philosophy toward information which is so critical to the successful development of information systems, particular attention in this report is focused on the information needs of merchandise and operations managers of retail food firms. The management of merchandise represents one of the central foci and major time requirements of managers of retail food firms. Opportunities exist both to improve the efficiency with which this management task is accomplished, and to improve the efficacy of merchandising decisions. In the authors' views, an effective information system represents one of the vehicles by which such improvements are possible.

Since a comprehensive information system requires time to develop, a three-stage pattern of development is suggested in Chapter 2. An elementary control system is developed initially, followed by an up-dated control system in Stage II, and an advanced control and planning system in Stage III. Each successive stage builds upon the system and data bank of the previous stage. For this reason and many others, the gradual development of an information system carries definite advantages over a crash program.

The OARDC information systems for meat and produce which are described and documented are similar in basic design to many of the systems currently being used by food firms. They contain greater capabilities and flexibilities than most industry systems, however. In particular, the OARDC systems include options to adjust for inventories, calculate labor requirements, adjust for various merchandising methods, and compare actual with computed results. While the computer programs and operating instructions are available in a technical supplement to this bulletin, few firms will choose to adopt these systems in their entirety. More likely, the general design, report formats, or computation procedures will be found useful by industry personnel and will be melded into their existing systems.

Once a comprehensive control system has been developed along with a data bank, the opportunities for employing more rigorous decision models are numerous. Three examples are included in Chapter 4, drawing on past research at the Ohio Agricultural Research and Development Center. While these models are demanding in the data and relationships required, a considerable pay-off seems likely. At this point in time, the cost-benefit ratios for such models can only be speculated, however.

By intent, the thrust of this report has been on ways of improving the efficiency of managers' time and the effectiveness of their decisions regarding merchandise and labor management. The efficiency dimensions of retailing are thereby emphasized. The authors acknowledge, however, the inherent dangers of firms becoming too preoccupied with efficiency considerations, to the detriment of customer service, imaginative merchandising, and employee development. This need not occur as a result of a comprehensive information system. A more precise method of controlling inventories, predicting sales, judging product profitability, scheduling labor, or ordering merchandise should not mean that customers are ignored, that all stores in a chain are homogenized, or that employee creativity is smothered. However, the danger is there and must be recognized. Information systems of the type discussed in this report *tend* to move a firm toward the routinizing of operations and decisions, toward uniformity, and toward more central control. Flexibility, diversity and individuality can very easily suffer unless they are carefully protected.

For these reasons, the development of information systems may carry more appeal to those firms which rely on efficiency and low prices as a major competitive weapon than to firms emphasizing non-price factors. The authors contend, however, that such systems can benefit all firms (although not equally), as long as they stick to their basic operating philosophy.

An information system approach is also appropriate for information needs not covered in this report. Since customer behavior has a major bearing on the success of food retailers, an information system to monitor consumer attitudes, images, and preferences is a logical consideration. A few manufacturing firms are attempting this on an on-going basis. A customer information system of some type would help balance the efficiency orientation of the systems discussed in this report.

The development and use of information systems is dependent upon the benefits perceived by individual firms. The benefits derived from such systems would not be limited to retail firms, however. Through more accurate ordering, inventory control, and labor management, efficiency should be increased, shrinkage reduced, and consumers better served. More information on individual product sales and profitability should facilitate more accurate reflection of consumer and retailer preferences to the rest of the marketing system. The price premiums for lean-type pork, for steers over heifers, or for certain weights of beef carcasses, for example, would be based more upon the increased value to retailers and consumers, and less upon hunch, folklore, and guesstimates if comprehensive information systems were in widespread use. While some retailers presently conduct cutting tests of different products, relatively little experimentation occurs in product procurement, at least in part because customer reaction is unknown.

The current progress toward electronic checkouts provides encouragement to an information systems approach. The computer to which these checkouts are connected will provide data with detail and accuracy which previously has not been possible. With this new technology on the horizon, it is an appropriate time for retail firms to consider a systems approach to their information needs.

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Green Springs Crops Research Unit, Green Springs, Sandusky County: 26 acres

Jackson Branch, Jackson, Jackson County: 344 acres

Mahoning County Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Pomerene Forest, Laboratory, Keene Township, Coshocton County: 227 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Western Branch, South Charleston, Clark County: 428 acres