APPLICATIONS OF COMPUTER PROGRAMMING

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Linda May Marston

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INTRODUCTION

In 1945, Vannevar Bush predicted the "advanced arithmetical machines of the future" would be electrical, more versatile than accounting machines, adaptable for a wide variety of operations, controlled by instructions, fast in computation, and capable of recording results in reusable form (35). The past twenty years have produced thousands of computers, each attesting to the remarkable veracity of Mr. Bush's statement.

In the past eleven years many improvements have been made in the speed and accuracy of computing equipment (74). At present, computers are being used extensively by government and industry, and changes in business activities during recent years have encouraged the creation of new data-processing systems (36). In spite of the rapid advances of technology, and the changes in the capacity and potential of new computers, planning for their use has not kept pace (25). Industrial and institutional uses of computers could be extended if more attention were given to scrutinizing the literature to prevent duplication of effort in developing programs and determining applications of data-processing equipment.

The purpose of this study is to provide a summary of basic information from which research of specific computer application may be developed for the food service department of Michigan State University. This summary has been achieved by reviewing the literature concerning applications of electronic data processing, and by soliciting additional information from equipment manufacturers and researchers in the food service area who, to date, have not

published their findings. Interviews with selected food service personnel at Michigan State University provided the author with an understanding of the time spent in menu planning, payroll computation, ordering and employee supervision. An understanding of computer applicability to Michigan State University food services, as visualized by the food service personnel, was also attained.

THE COMPUTER

In the past twenty years, computers have evolved into such complex machines, it is difficult and unnecessary to give a detailed description of the machines' operations. For the purpose of this paper, it is sufficient to understand a computer is a system which accepts information, performs calculations and other required symbolic manipulation, and displays the results of its work in a convenient form. Information presented to the computer must be in a standard medium, for example, punched cards or tape. The information received from the computer is also in a standard medium, usually print.

Today, the more than twenty thousand computers in use in the United States are running at speeds up to millions of operations per second (35). The ability of the computers to understand directions and information fed into them has been broadened by the development of elaborate programming systems (35). The memories of computers have been improved to the point where they are virtually unlimited in size over a range of times of recall.

Terminology

The following definitions are presented to provide a standard meaning for terms having a significance in data processing. It is hoped they will facilitate communications between the author and the readers of this paper. All definitions have been compiled from Automatic Data-Processing Systems by Gregory and Van Horn (36).

1. Arithmetic Unit: the portion of hardware of an automatic digital computer in which arithmetical and logical operations are performed.

2. Automatic Data-processing System: a system that utilizes minimum manual operations in data processing.

3. Computer: any device capable of accepting data, applying prescribed processes to them, and supplying the results of these processes.

   Analogue Computer: a computer which calculates by using physical analogues of the variables.

   Digital Computer: a computer capable of accepting and operating only on the representations of real numbers, or other characters coded numerically.

4. Control Unit: portion of the hardware of an automatic digital computer directing sequences of operations, interpreting coded instructions, and initiating proper commands to computer circuits to execute instructions.

5. Data: figures, words, or charts that refer to or describe some situation.

6. Data Processing: rearrangement and refinement of raw data into a form suitable for further use.

7. Hardware: the electronic and mechanical equipment used for data processing.

8. Input: the introduction of data into the internal storage of the computer.

9. Magnetic-tape Storage: a storage device of metal or plastic tape coated with magnetic material.

10. Output: the process of transferring data from internal storage of a computer to another storage device.

11. Program: a plan for the solution of a problem, including plans for transcription of data, coding, and absorption of the results into the system.

12. Read: to copy, usually from one form of storage to another.

13. Storage: a device capable of receiving data, retaining them for an indefinite period of time, and supplying them upon command.

Evolution

In the time it takes you to read this sentence, an electronic computer could perform three million mathematical operations (38). The tremendous growth of electronic computers is called, by many authors, the second industrial revolution. The cause of this revolution has not appeared as an invention created overnight; the computer has a long history (38).

One of the earliest forms of computing equipment is the abacus, developed approximately 5000 years ago, and still in use in many parts of the world. During the nineteenth century, Joseph Jacquard automated a loom by a series of cards with holes punched in them. The insertion of various combinations of cards into the loom created different designs--the basic idea of modern computers. At about the same time, a man named Wolfgang von Kempelen built a chess-playing machine called the Maelzel Chess Automation. The man and his machine became known throughout Europe, and it was several years before it was discovered there was another man hidden inside the machine. Von Kempelen's invention doubtless spurred other inventors to develop similar machines, and by 1914 a Spaniard had succeeded in building a machine capable of playing the game. Before this time, an English scientist, Charles Babbage, worked for years to develop a machine to do mathematical calculations to twenty decimal places. Babbage died in 1871 without completing the machine, but his plans were strikingly similar to many modern computers appearing in the United States about 1945 (55).

Growth in the United States

Computers have experienced a rapid growth in the past twenty years (34). The 1962 domestic market for computers was approximately three billion

dollars (38). Three areas in which computers have found widespread application are government, industry, and colleges and universities.

Government

The computer has become of sufficient importance to the government to warrant the establishment of the Interagency Data Processing Committee (38). A total of forty-three agencies, including the Department of Defense, the Atomic Energy Commission, the Department of Commerce, the National Aeronautics and Space Agency, the Post Office Department, and the Federal Income Tax Bureau are users of computers.

Included in the areas of application of computers in government are mathematical calculations of the census, and computation of individual income taxes. Computers are used in military research, development, and tactical and strategic methods (38). It was a computer which enabled us to develop a hydrogen bomb before the Russians (38). The exact trajectory of space vehicles is plotted by the computer, and the mathematics required to determine the course of space flights would be impossible for men to calculate in a reasonable amount of time.

The increasing use of computers in government has raised some interesting questions, the answers to which will only be known after several years of use. Will the use of computers by government limit decisions only to those people who have a knowledge of computers, and can these men influence the decision of the computer by the writing of the program (34)? Whatever the answer to these questions, it is evident computers have entered government and will remain an integral part.

Business and Industry

Almost from their inception, over fifteen years ago, it was expected electronic computers would eventually be applied to problems of business and

industry (55). The technology took hold in business, and its total significance is still difficult to evaluate (49). The birth of computers in business was in the Major Appliance Division of the General Electric Company in 1954 (60). By 1961 there were over 6000 large computers in use.

Computers have found application in banking establishments, insurance companies, department stores, supermarkets, and drug stores. Hotels, turnpikes, communication agencies, and advertising establishments have all found computers applicable to their businesses, but computers have been found equally applicable to jobs in oil refineries, chemical plants, steel mills, and airlines. The high-volume capacity, speed, and accuracy of the computer make it a welcome addition to most businesses and industries (38). The speed inherent in computers makes it possible to test new policies or manufacturing programs in hours rather than waiting months for the actual application and possible failure (38). It is predicted most businesses will be using computer simulations of their organizations by 1966.

Colleges and Universities

Accompanying the tremendous growth of computers in government and industry was the inevitable inclusion of computers in colleges and universities. The computer was first applied to mathematical and scientific work, and later to business and the training of future executives (38). Computer centers, located in many colleges and universities, train students in computer use and carry on research.

Many problems face university computing centers. Financial problems are pressing in many schools, and the computer centers must depend on underpaid, inexperienced students for a large part of their operating staff (57).

Training is often superficial, problems often ill-conceived and poorly programmed, and research shallow.

When looking at the problems faced by most college and university computer centers, we must realize computers were first introduced in colleges and universities about 1956. After only seven years 518 digital computers have been installed in 294 American colleges and universities (57).

THE IMPACT OF COMPUTERS ON MANAGEMENT

Management installs computers for diverse purposes. For example, the purpose of many modern data-processing systems is to provide a framework for decision making activities (55). Decision making, which has always been performed by people, can now be performed by computers. The ability of the digital computer to make decisions is often described as one of the characteristics of this type of equipment. In addition, computers are utilized to tie together the channels of communication present in the management processes of planning, operating, and reviewing (11). Computers improve communications by eliminating the passing of partial information from one department to another and the resulting duplication of effort (67). According to Schultz and Whisler (64), in a few years creative thinking may be the greatest advantage of computers over men. It is difficult for one man to tell another how he thinks, and thus communicate his creative ability, but it is possible to determine the exact manner of creative achievements of the computer. Finally, computers are used to enable large companies to be operated with the efficiency of small companies (64).

Since the 1940's the technology of computers has begun to take hold in American Business (49). The technology, however, has outstripped man's ability, or at least his willingness, to comprehend and control it (32). Although intrigued by the capacity and potential of computers, people have failed to plan adequately for the application of the machines. Suitable

applications for electronic data-processing systems are limited only by the ability of computer users to see clearly the scope and power of the new technology (8).

When a business or industry makes the decision to install an electronic data-processing system, the industry should be aware that change for change's sake is not acceptable in electronic data-processing (24). Before installing a system, it is necessary for management to determine the present costs of the business, the areas in greatest need of improvement, the areas to which electronic data-processing can be applied, and the type of system needed (24). In addition to analyzing the problem, management must clearly state its objectives in installing a data-processing system (67). The objectives should include both the short- and long-range plans, and the assignment of responsibility for attaining the objectives. One of the greatest initial contributions of a computer to a business or industry is the discipline which the installation demands in the understanding of the operation; a computer can tolerate no ambiguities (59).

The effect on the organization has only begun when the computer is first installed; the changes following are generally greater than recognized (66). After a computer has been installed in an operation, management will find certain radical changes taking place in administrative practices (49). By and large, it is management that determines the success or failure of the electronic data-processing system (74). Management finds itself pressured by the system to make changes in the direction of centralization of decision making, control and co-ordination. Information used for decision making in an organization will, of necessity, be quantified for use in computers (66). Planning periods and communication times will be shortened by the use of computers, thus reducing poor decisions caused by internal time lags in the

flow of information. Management may find its entire concept of decision making has changed after the installation of a computer.

Other changes which must be faced by management are: the increasing frequency of multiple entry points into the organization, the multiple sources of potential managers, the apprenticeship as a basis for training managers becoming less common, the training of top-management to be taken over increasingly by universities, the appraising of middle managers becoming more precise (49). Before installing a computer management should be aware that these changes are to be expected if success is to be achieved with the data-processing system.

Although the installation of a computer will affect all levels of management, middle-management will be most affected. Extensive programming of computers will be concerned with the daily tasks of present middle-management (64). Because many of the present decisions made by middle-management are routine, determined by formal policy, system structure, and precedent, these decisions are especially applicable to programming for computers (34). Computers may result in the professionalization of middle-management, and the consequent simplification of the change between middle- and top-management positions (64).

The impact of computer installation on management presents many problems. The problems are peculiar to each operation and demand a high degree of judgment, salesmanship, and organizational ability on the part of the head of the electronic data-processing operation (1). He must take time to study the company's over-all objectives and operations, and the factors involved in successful electronic data-processing installations.

For those companies contemplating a change, there are seven areas of planning which generally are the sources of conflict and, therefore, deserve

special attention. The areas are: an inept approach in dealing with others--conflict caused in part by a concentration on problems rather than solutions; methods analyst's interest in the equipment being greater than his interest in the company; a manpower shortage in the changeover; management pressure for early installation; a lack of participation by supervisory employees; a lack of planning for transfers and reclassified personnel; an insufficiency of information of what is needed and expected (53). Among the recommendations for the success of an electronic data-processing installation is the suggestion for the inclusion of at least one member of each group affected by the change in the automation planning committee. Because supervisors play a key roll in the success or failure of the system, special attention should be given to educating them (53). All workers should be shown the reasons for the changes to electronic data-processing and the effect it will have on each worker. The use of tact in the installation of a computer system can determine its acceptance by the company as a whole.

Although computer installations have a great impact on management, successful installation is possible through an understanding of the problems usually faced by management. Implementing recommendations for an installation of the system will increase the probability of satisfaction.

THE APPLICATIONS OF COMPUTER PROGRAMMING

During the past two decades, the applications of computers have increased far beyond the expectations of business men of the 1940's. Even a man as clairvoyant as Dr. Bush would not have predicted twenty years ago the wide range of computer application. It is not the purpose of the author to try to discuss all the present computer programs--just those of particular significance which might be adapted to food service. Selected computer programs have been drawn from industry, agriculture, hotels, and food service as applications potentially usable by the Michigan State University Food Services.

Computers in Industry

If management has taken the precautions suggested in the previous section, the installation of a computer can result in many varied and successful applications. To date, however, many industries have not taken these precautions and, as a result, are not realizing a profit from the installation of computers (12). The more mathematical and computational a particular business or industry, the more likely is the application of automatic computing machinery (9). However, there is nothing about a computer which limits its capacity to manipulating numerical symbols; it can manipulate words as well (65).

Many of the present applications of computers in industry are mathematical and computational in nature, but non-mathematical applications are being

included in several programs. Electronic computer applications used by industry include: accounting distribution, budgeting, cost accounting, file maintenance, labor distribution, manufacturing scheduling, operational analysis, ordering, billing, payroll processing, report preparation, sales analysis, shop-load scheduling, and inventory control (8).

One of the most widespread applications of computers in industry is payroll processing. To figure payrolls using the IBM 1401 computer, a payroll card containing the following information is punched: card columns 1-4, clock number of the employee; columns 5-7, type number indicating the type of deduction; columns 8-22, last name of the employee; column 23, first initial of the employee; column 24, second initial of the employee; columns 25-30, rate of pay; columns 31-32, number of dependents; columns 33-39, total pay to date; columns 40-45, total income tax taken to date; columns 46-50, total social security taken to date; column 51, "x" punched if social security is not to be taken; columns 52-59, social security number; column 80, card code (58). A summary card is also prepared including the following information: card columns 1-4, clock number of the employee; columns 5-7, type number; columns 8-13, rate of pay; columns 14-20, total pay to date; columns 21-26, total income tax to date; columns 27-31, total social security taken to date; columns 32-38, total amount of pay due (gross); columns 39-45, net pay due; columns 46-52, total pay to date including this pay; columns 53-60, social security number; column 80, card code.

The Ford Motor Company's Manufacturing Services located in Dearborn, Michigan applies its computer to payroll, sales analysis, and inventory (31). The computer does both the hourly and salary payroll for most of the Ford plants in Michigan. The hourly payroll includes between 65,000 and 70,000 employees per week. Each Ford plant furnishes the basic payroll authorization

and weekly time reports to the central data-processing division. The time cards are key punched and sorted by employee badge number and converted to magnetic tape. Three tapes are processed through the IBM 705 computer: the hours worked tape, the new hire master tape, and the previous week's employee master tape which includes the badge number, name, social security number, department, rate of pay, deductions, earnings to date, and deductions to date.

Computers are capable of diverse applications. Routine decisions can be programmed and made automatically. The major steps in programming decision making or problem solving are: erecting goals, detecting differences between the present situation and the goals, finding processes relevant to reducing the differences, and applying these processes to solving sub-problems before attempting the entire problem (65). Computers will affect decision making in an organization by quantifying the information used for decision making and broadening the scope of these decisions. Information technology will also shorten the planning period and depersonalize decisions (64). To avoid making the decision process rigid, a new approach to the programming of decisions has been introduced. The Bayesian approach allows people to use their own judgment as if it were statistical information (16). In this way, human intuition, experience, and cleverness can be combined with basic information to reach the decisions. In many industries middle-management is spending too much time on routine decisions which could profitably be computerized.

For industries with a number of decentralized operations, inventory control can be time consuming, and if inefficiently carried out can be a source of drain on potential profits. Inventory control programs are available from the International Business Machines Corporation, and can be applied

to many businesses (44). Westinghouse uses nationwide inventory control by electronic data-processing, and it has resulted in a decreased level of inventory across the country (12). In a manufacturing concern, the data-processing department uses a copy of the packing list from the shipping department to prepare key-punched cards indicating the order number, quantity shipped, and charges. A seven-part invoice form is processed with the simultaneous recording of inventory (40).

The output of data-processing divisions of various companies differs depending on their needs. For example, as the canning industry has grown, the need to develop a computer program to forecast sales analysis has become of great importance (70). A program was devised using the order sheets written each day. The order detail cards are held until required for the preparation of the sales analysis. The program output includes the sales analysis, the quantity ordered, the customer code number and a variety code number.

The General Electric Company was the first corporation to use computers in the management aspects of industry. In 1953, a computer was installed in the Major Appliance Division at Louisville, Kentucky and a program written to balance assembly lines and feeder lines (60). Two main objectives in developing a program to control production lines are: to collate orders and arrange them in appropriate sequence for the most economical manufacture, and to set up each machine for the particular orders to be filled (12).

It is not surprising industry has applied computers to such a variety of uses. Because industry is concerned with making a profit, and because computers appear to be a potential for increasing net profits, the growth of computers in industry over the past decade has been tremendous.

Computers in Agriculture

Although the application of electronic data-processing is not as widespread in agriculture as it is in industry, in the past five years computer programs have been utilized to aid the farmer. The farmer has to analyze production, distribution, supply and demand, economic growth, yield, time of harvest, climate, and prices (2). One of the optimal uses of computers in agriculture, at present, is the capability of selecting crop rotation, and types and numbers of livestock considering the resource limitations of the farm. Computers assist the farm manager in organizing a farm by suggesting the best plan for planting and harvesting corn, oats, soybeans, and hay (2).

The state of Michigan has instituted a mail-in farm account system, whereby a farmer can maintain accurate records of the monetary income and output of all aspects of the farming operation. In this way, a farmer can determine what areas of his operation are yielding a profit and what areas a loss. The objectives of the mail-in farm accounts project include business analyses, trend information, and case studies (21). Michigan State University utilizes the CDC 3600 electronic computer to calculate annual financial statements and quarterly and annual reports which are mailed to the farmer.

Crosfields and Calthrop Limited, a cattle feed manufacturer in Liverpool, England, is using a computer to program methods of buying and mixing products for animal feeds (4). The program provides a daily guide of what to buy, according to availability and price, and evolves recipes conforming to the nutritional requirements of the animals at the most economical cost. Once devised, a program such as this might be modified and applied to human nutrition.

Computers in Hotels

In the past three years, the application of computers has been extended to the hotel industry. All major accounting systems were studied by the hotel industry, and the final applications include guest accounting, registration, mail information, guest charges, restaurant billing, telephone charges, valet charges, night audits, and checkout (20). Accounts receivable, accounts payable, and payroll are also programmed (26). The Holiday Inns of America have programmed their payroll for 5,800 employees (23). The payroll, involving as many as five payroll deductions for each employee, can be calculated and printed by means of the computer in less than four hours (23).

Many hotels have applied computers to the calculation of food and beverage control. The control covers the entire area of food and beverage handling, from planning menus and determining the food requirements through the end results of relating item sales to cost (20). From the known sales data comes much of the knowledge used to plan optimum menus in the future. The food control report has ten columns of information containing 1) the menu item code, 2) the menu item description, 3) the number of covers sold, 4) the number of portions sold, 5) the number of portions prepared, 6) the number of portions leftover, 7) sales, 8) the cost of goods, 9) the gross profit, and 10) the cost of leftovers (19). Maintaining the food and beverage report can be simplified by the installation of a National Sales-Tronic cash register. The cash register automatically records charges made in an IBM card punching machine. At the time of billing the customer, the cashier is simultaneously itemizing each meal and creating a punched card record of sales (10).

Computers in Food Service

Computer applications peculiar to food service are few in number. The majority of programs which apply specifically to food service have been written in the past two years. Included in this group are cafeteria service line simulations, kitchen layout cross charts, employee scheduling, food inventory control, menu planning, and menu nutrient calculations.

Simulation

Simulation is defined as the setting up of a model of a real situation and performing experiments on the model by manipulating numbers or other symbols (46). It appears simulation has possibilities for studying the effect of changes in layout or operating procedures before any change takes place. In her doctoral thesis, Knickrehm (47) showed the potential uses of the simulation technique to determine the effect of changes in layout and operating procedures on the time customers spend in a cafeteria service line, the rate of flow of customers, and the utilization of facilities (46). The data used in the simulation showed the inter-relationship of the operations and had a frequency distribution for each condition studied.

Data were collected in a single-line cafeteria, and service times for each station were obtained by using a stop watch. The stop watch ran from the time a customer entered a station until he had given his order or placed his selection on his tray. For each station Knickrehm calculated the mean, standard deviation, and number of readings required for a 95 per cent confidence level (46). Cumulative frequencies of service times were plotted for each station.

Two computer programs were written by Knickrehm; one program used empirical data for selecting service time, and the other program used theoretical

data. They were written in Fortran language from flow diagrams of the cafeteria layout, and results obtained from using empirical data in program I or theoretical data in program II were similar. Appendix Exhibit 5 illustrates the flow diagram for the first section of the hot food station. The programs calculated 1) the average total time in the system; 2) the average total waiting time; 3) the average total service time; 4) the average service time at each station based on the number of people actually requesting service at the station; 5) the average waiting time at each station; and 6) the number of people requesting service at each station. Knickrehm used four subroutines to generate random numbers, calculate service times, establish times for each position and service clock, and time for beginning of service at each station. Appendix Exhibit 6 illustrates the subroutine "Move" establishing the time for the position and service clock.

The service of 1000 customers was simulated by the two programs after the system had been operating long enough to obliterate the effect of initial starting conditions. Each program included three simulations, and there was as much variation among the simulations of each program as there was between the two programs (46).

Simulation is a scientific technique developed by industry and now used by the food service industry to improve the efficiency of operations. Through the technique of simulation, the model of the system can be easily manipulated, whereas it would be impractical or impossible to perform the actual experiments on the system represented.

Cross Charting

A satisfactory kitchen layout is one in which materials in production move a minimum distance, shortening production time, decreasing employee's

effort and fatigue, lowering labor costs and materials-handling costs, and aiding in simplification of supervision. Because the problem in food production is one of planning the most efficient layout for a variety of menu items and a number of different pieces of equipment, the cross chart has been utilized to plan the layout.

Gottlieb and Couch (33) extended the study of the cross chart method of layout planning to test a number of menu items typical of those served in an institution kitchen. Factors important in the study included the distance between pieces of equipment, importance of the menu item, production time, labor cost, and the value of additional or duplicate pieces of equipment. Because there is a large amount of data collected for cross charts, computers are used to produce the charts and calculate the efficiency percentages.

To simplify the explanation of the cross chart method only one menu item will be charted. Exhibit 1 illustrates the item chosen. The item, cheese souffle, has eight ingredients requiring a number of processes and using several pieces of equipment. The cross chart lists the equipment used on the horizontal and vertical axes to indicate both backward and forward movements. Exhibits 2 and 3 illustrate the cross charts of the preparation of cheese souffle. A diagonal line on the chart separates the two listings of equipment; the upper field shows back-tracking movements and the lower field forward movements. Movements made to adjacent pieces of equipment are noted by recording the appropriate number adjacent to the diagonal line. The more efficient the kitchen layout, the more numbers will appear below and adjacent to the line, indicating the predominance of forward trips made chiefly in the sequence of equipment arrangement.

EXHIBIT 1.--Cheese souffle recipe, indicating procedures, trip sequences, and equipment required

Ingredient	Process	Trip	Equipment
Nonfat Dry Milk	Weigh	1	Table
Salt	Weigh, transfer		Table
	to sink	2	Sink
Water	Measure, mix milk, salt and water	3	Bain-Marie
Margarine	Weigh	4	Table
Flour	Weigh, add to heated margarine,	5	Range
	stir into hot milk	6	Bain-Marie
Cheese	Weigh,	7	Table
	chop,	8	Chopper
	stir into sauce,	9	Bain-Marie
	remove to table	10	Table
Frozen Egg Yolks	Weigh, beat, add to sauce		
Frozen Egg White	Weigh, beat,	11	Mixer
	fold into sauce	12	Table
	bake at 300°	13	Oven
	product out	14	

Source: Regina Gottlieb and Mary A. Couch, "Using the Cross Chart in Planning Kitchen Layouts," Journal of The American Dietetic Association, XXXVI, No. 6 (June, 1960), 586.

EXHIBIT 2.--Cheese souffle, equipment sequence of first trial

TO \ FROM	Ingredient Issue	Sink	Table	Oven	Range	Bain-Marie	Mixer	Chopper	Product Out	Total Horizontal	Total "From" Trips
Ingredient Issue										0	0
Sink			2							1	1
Table	1					4,7 10	12			5	4
Oven			13							1	0
Range			5							1	0
Bain-Marie		3			6			9		3	1
Mixer			11							1	0
Chopper			8							1	0
Product Out				14						1	0
Total Vertical	1	1	5	1	1	3	1	1	0	14	6
Total "To" Trips	1	1	4	1	1	0	0	0	0	8	

Source: Regina Gottlieb and Mary A. Couch, "Using the Cross Chart in Planning Kitchen Layouts," Journal of The American Dietetic Association, XXXVI, No. 6 (June, 1960), 587.

EXHIBIT 3.--Cheese souffle, improved equipment sequence

TO \ FROM	Ingredient Issue	Chopper	Bain-Marie	Table	Sink	Mixer	Range	Oven	Product Out	Total Horizontal	Total "From" Trips
Ingredient Issue										0	0
Chopper				8						1	1
Bain-Marie		9			3		6			3	2
Table	1		4,7 10			12				5	1
Sink				2						1	0
Mixer				11						1	0
Range				5						1	0
Oven				13						1	0
Product Out								14		1	0
Total Vertical	1	1	3	5	1	1	1	1	0	14	4
Total "To" Trips	1	1	3	4	0	0	0	1	0	10	

Source: Regina Gottlieb and Mary A. Couch, "Using the Cross Chart in Planning Kitchen Layouts," Journal of The American Dietetic Association, XXXVI, No. 6 (June, 1960), 587.

To improve layout efficiency, those pieces of equipment with the greatest number of trips between them can be placed to minimize back-tracking and by-passing. Efficiency is considered to be the ratio of the number of trips forward to the total number of trips. To evaluate the layout for trips deviating from the equipment sequence, forward trips are weighted according to the number of pieces of equipment by-passed. The back-tracking trips are weighted by twice the number of pieces by-passed.

When calculating a number of menu items, a computer can be utilized by translating the cross chart into the machine language of numbers. The program is fed into the computer, and the output appearing on cards or tape is re-coded and printed, enabling the researcher to make interpretations and applications of the results.

Scheduling

Purdue University, a resident institution housing and feeding most of its students, has developed a computer program which schedules the student's classes and his hours of employment in the dining halls. The hours worked in the resident halls are fed into the computer in the same manner as the academic courses. Waiter hours, scheduled by the computer, conflict with academic courses less than 20 per cent of the time. In the case of a conflict, the computer prints a note on the student's schedule advising him to see the Foods Manager (11).

The semester before employment is desired a student may arrange for employment with one of the residence halls. If a two-hour lunch period is needed, a "travel time" course card may also be fed into the computer. The employment requests along with the requests for activities or intercollegiate

athletics are added to the student's academic courses and scheduled on the computer.

A list of potential student employees is forwarded to the Registrar, fed into the computer, and sent to the Foods Manager as a "class list" of employees. The system requires cooperation between the academic areas and the residence halls. If the Foods Manager ignores the needs of the academic areas, a workable program will not be possible.

Food Inventory Control

Food inventory control can be a difficult problem for a large food service operation. The Memorial Hospital in Wilmington, Delaware, has improved its food inventory control by computer programming to such a degree that the staff now plan and prepare 48,000 meals per month with a maximum overage of five servings per meal (23).

Complete and fully effective food control presently requires much laborious and time-consuming effort. Food control reports are often obtained too late to be of value to the food service. Sayles (28) of Cornell University has prepared a preliminary report on food inventory control programming. With refinement this report could be utilized by food services as a guide in computer programming to maintain an up-to-date food control system.

The boundaries of control, as presented in the Sayles' report, start with debits to transfers to various areas and credits to transfers-suspense, which in normal account distribution is cost of sales. The boundaries end with a final credit to transfers and a debit to cost of sales-food. Before computations can be undertaken, the Food Service Manager must know the following: 1) the value of all transfers associated with the area, 2) the value of prior and present inventories, and 3) the value of all waste.

Menu Planning

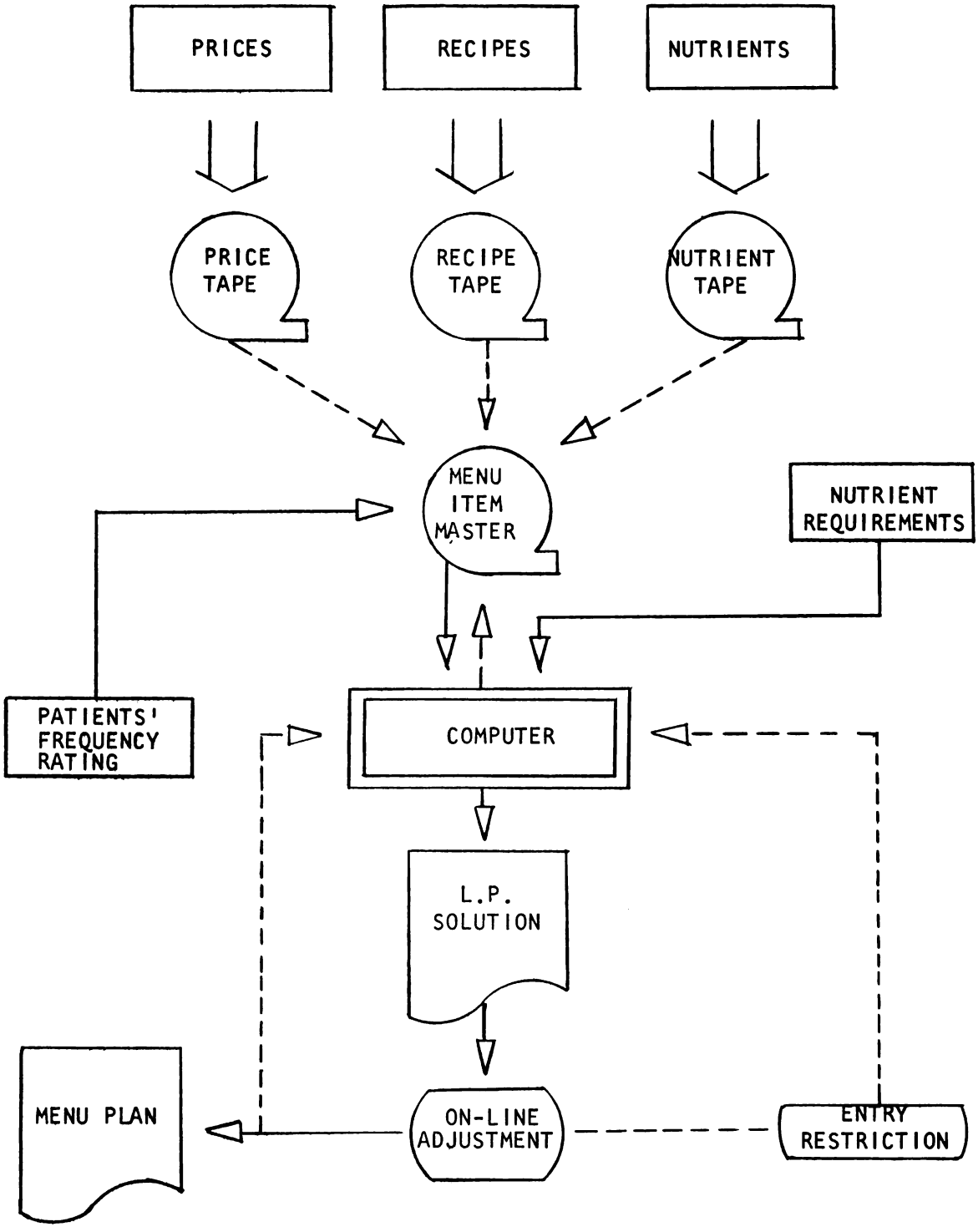
Joseph Balintfy, Associate Professor of Operations Research in the School of Business Administration at Tulane University, has developed a computer program for writing normal and modified hospital diets. The research is supported by the National Institutes of Health, and a Fortran program for the IBM 1410 has been developed.

When planning menus the dietitian is concerned with three main objectives: 1) achieving high customer satisfaction, 2) providing nutritionally balanced diets, and 3) meeting the constraints of the budget. These three objectives can now be significantly improved by the use of the computer (6). Menu planning by computer not only improves the quality of menus, but also aids in reducing food costs.

Computers can insure that all nutritional requirements are met by the diet each day, and the preferences of the customers are considered. By storing data of the variables which enter into the daily planning of menus, computers process these variables against mathematical decision rules which have been programmed. The computer then prints the day's menu, assuring it is the lowest cost menu feasible, satisfying all nutritional factors. If an item appears on the menu which is unsatisfactory to the dietitian, she can type out a message to the computer telling it to strike the particular item and substitute one of her choosing.

A schematic drawing (Exhibit 4) illustrates the entire computer process. There are four sets of information placed in the computer's memory: data on food prices, recipes of menu items, nutrient composition of foods, and customers' frequency preferences. The food price information should be as up-to-date as possible. The nutrient calculations can include as many

EXHIBIT 4.--Flow chart of computer process



Source: Joseph L. Balintfy, "Mathematical Programming for Menu Planning," Paper read at the Industrial Engineering Hospital Seminar, Ann Arbor, February, 1964, p. 21.

nutrients as desired, including essential amino acids and unsaturated fatty acids. The recipes describe the menu item as a detailed list of ingredients, along with the quantities in 100 gram portions. The portion size for the menu item can be adjusted if management wishes to increase or decrease the serving size. The mathematical programming to handle these four menu planning factors is available to hospitals interested in the technique from the Tulane School of Business Administration and the Touro Infirmary of New Orleans.

The print-out sheet of the computer takes 40 seconds to produce, and includes each menu item and its cost, the nutrient content of the menu and the percentage amount by which the menu meets the Recommended Dietary Allowances. The regular menu can then be easily modified to produce menus higher or lower in calories to compensate for the needs of different types of customers. Any other revisions desired for special dietary problems may be produced, with the resulting menus still meeting the Recommended Allowances at the lowest possible cost.

The program developed by Balintfy planned menus which more consistently met the Recommended Dietary Allowances of the hospital patients and reduced food costs approximately 25 per cent when compared to the menus developed by the dietitians (6).

Menu Nutrient Calculations

The Veterans Administration Hospitals, faced with the problem of frequent calculations of menu nutrients, have used computers to undertake this laborious, time-consuming, and costly operation. Twenty-eight of the one hundred and seventy Administration Services are now participating in the computerized process (16). Regular and modified menus for patients and domiciliary members

are analyzed on the basis of fourteen nutrients. Daily and weekly nutrient averages are printed by the computer for each type of diet. Presently, the system is designed for dietetic planning and management.

A master deck of cards for each food item are maintained at a central processing center. Each card contains the code, gram weight, percentage of water, and nutritive values for the food item. Also maintained at the processing center is a set of description cards containing the item number, its nomenclature, and the household serving portion. The computer combines the set of description cards and master deck cards to print a listing called the "Nutritive Value of Foods Catalog."

The hospitals calculate eight different types of menus, the types coded one to eight. The days of the week are also coded one to seven, Sunday being number one. As a result, the print-out sheet of the computer includes columns showing the code for the type of diet and the day of the week.

The centralized calculations of menu nutrients have many advantages: accuracy, saving of professional time, ease of operation, standardization of nutrients calculated and sources of nutrient figures, increase in the number of nutrients calculated, and content figures for individual food items rather than classes of food. The use of computers in calculating menu nutrients has proven not only possible, but also advantageous when compared to manual calculations.

POTENTIAL APPLICATION OF COMPUTERS TO FOOD SERVICES AT MICHIGAN STATE UNIVERSITY

The preceeding sections of this paper have discussed numerous applications of computers in areas such as business, industry, agriculture, hotels, and food service. Michigan State University Food Services could profitably adapt many of the applications discussed by utilizing the facilities available at the University Computer Laboratory. The more recent acquisition of a CDC 3600 system and an IBM 1401 data-processing system have been a substantial improvement over past facilities. While both are high-speed electronic computers, they are designed to accomplish different types of calculations. In general, the CDC 3600 is suited to scientific analysis and the IBM 1401 is suited to business data processing.

The IBM 1401 computer was developed to provide a system which combined the functions of reading, punching, printing, calculating, and summarizing (30). The system bridged the gap between the advanced punched card units and the stored programmed systems. The 1401, which is a medium-scale system, has been programmed for complicated billing operations, invoice numbering, central inventory control, and summary punching (30).

The Agricultural Experiment Station, the Communications Research Center and the Computer Institute for Social Science Research have developed a number of statistical programs for the CDC 3600 computer. As of May, 1964, programs included: analysis of variance, factor analysis, simple correlations, means, standard deviations, moments, variances and covariances of variables

and sums of squares and cross products, least square fits to arbitrary functions, frequency distribution analysis, pattern analytic methods, and other programs available on request.

Efficiency is a goal toward which all food services should strive, and equipment layout is an important factor determining efficiency. Applications of the CDC 3600 and the IBM 1401 might include cafeteria line simulations and kitchen layouts. These programs could be profitable in planning dormitory food services in the future, and could be presently useful in existing installations with mobile equipment.

A third program which could be applied to the Food Services in the near future is the menu planning program. By interviewing selected food service personnel, the author was made aware of the fact there was difficulty in planning menus for the dormitory complexes serving male and female students. The menus must satisfy the caloric requirements of both groups, as well as special diets desired by some students to lose weight. The program developed by Joseph Balintfy to plan menus by computer can print-out menu variations to meet the needs of these groups. In addition, the program would enable the food service supervisors to know whether the menus offered were meeting the nutritional requirements of the students each day.

A fourth program concerning the scheduling of student employees in the food services could be applied to the larger dining complexes on campus, to good advantage. The program is available from James F. Blakesley, Administrative Coordinator of Schedules and Space, at Purdue University.

Payroll computation, which at present is only partially figured by computers at Michigan State University, could easily be converted to complete computation. A program similar to the one described on pages 14 and 15 of

this paper could be calculated on the IBM 1401 computer available on campus. The payroll can be calculated for employees on the hourly and salary pay scale with as many deductions as necessary for each employee. The program could save valuable supervisory time, and possibly result in greater accuracy for payroll computation.

Additional programs which may find potential applications in the food services include: sales analysis, inventory control, ordering, accounts receivable and payable. An inventory control program which could be adapted to the needs of the food services is available from the International Business Machines Corporation upon request. Sales analysis programs, if utilized, would aid the food service supervisor in planning the number of servings of each menu item to be offered. One food service employee interviewed stated a need for such a program. Dormitory food services constructed in the future may profitably be equipped with a National Sales-Tronic Cash Register, if such a program is undertaken.

The potential application of computers to food service is limited only by the ability of the food service personnel to recognize a need and an area of possible application. The programs discussed in this section are those which could be applied in the immediate future as they are available from other universities or IBM. Applications drawn from industry, hotels, or agriculture could be applied to food service with the aid of an experienced programmer.

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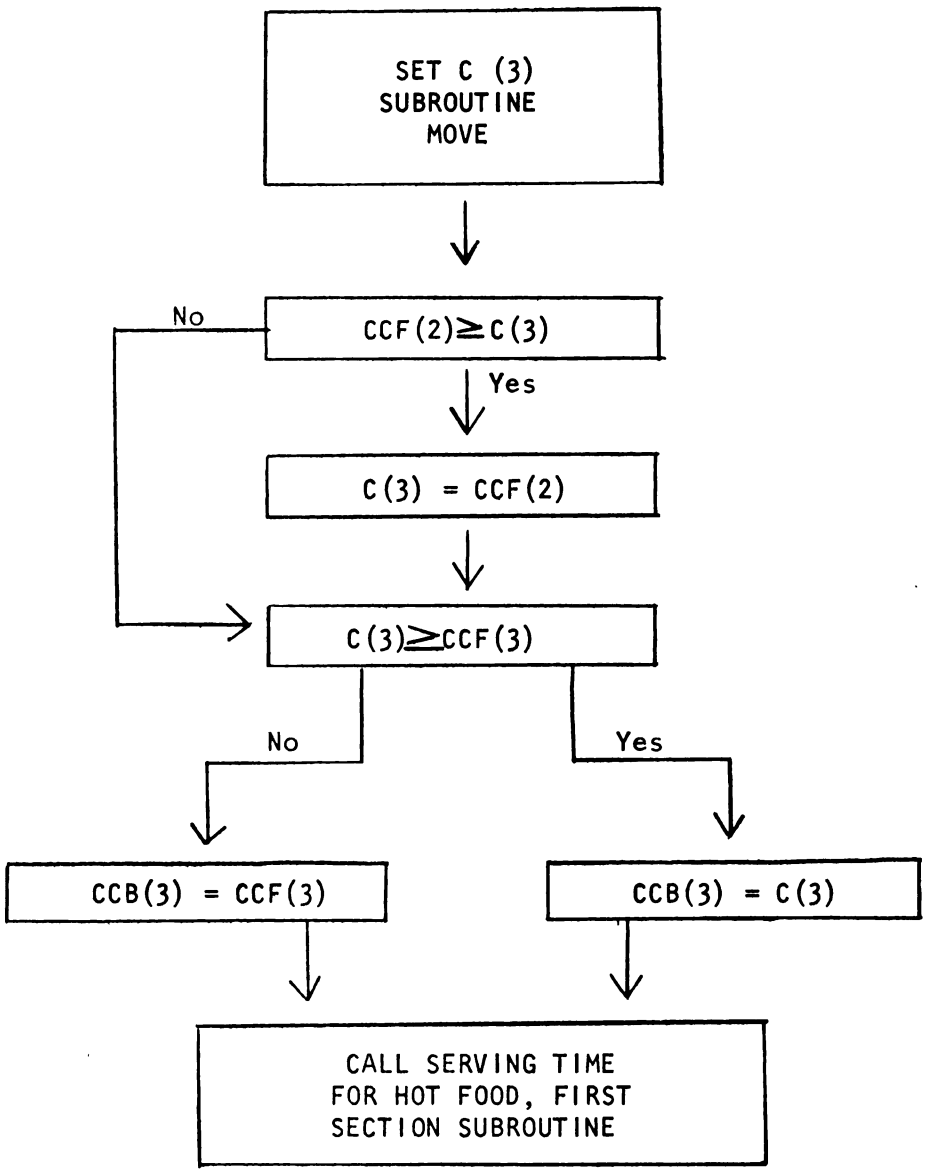
APPENDIX

EXHIBIT 5.--Flow diagram of hot food station for cafeteria service line simulation



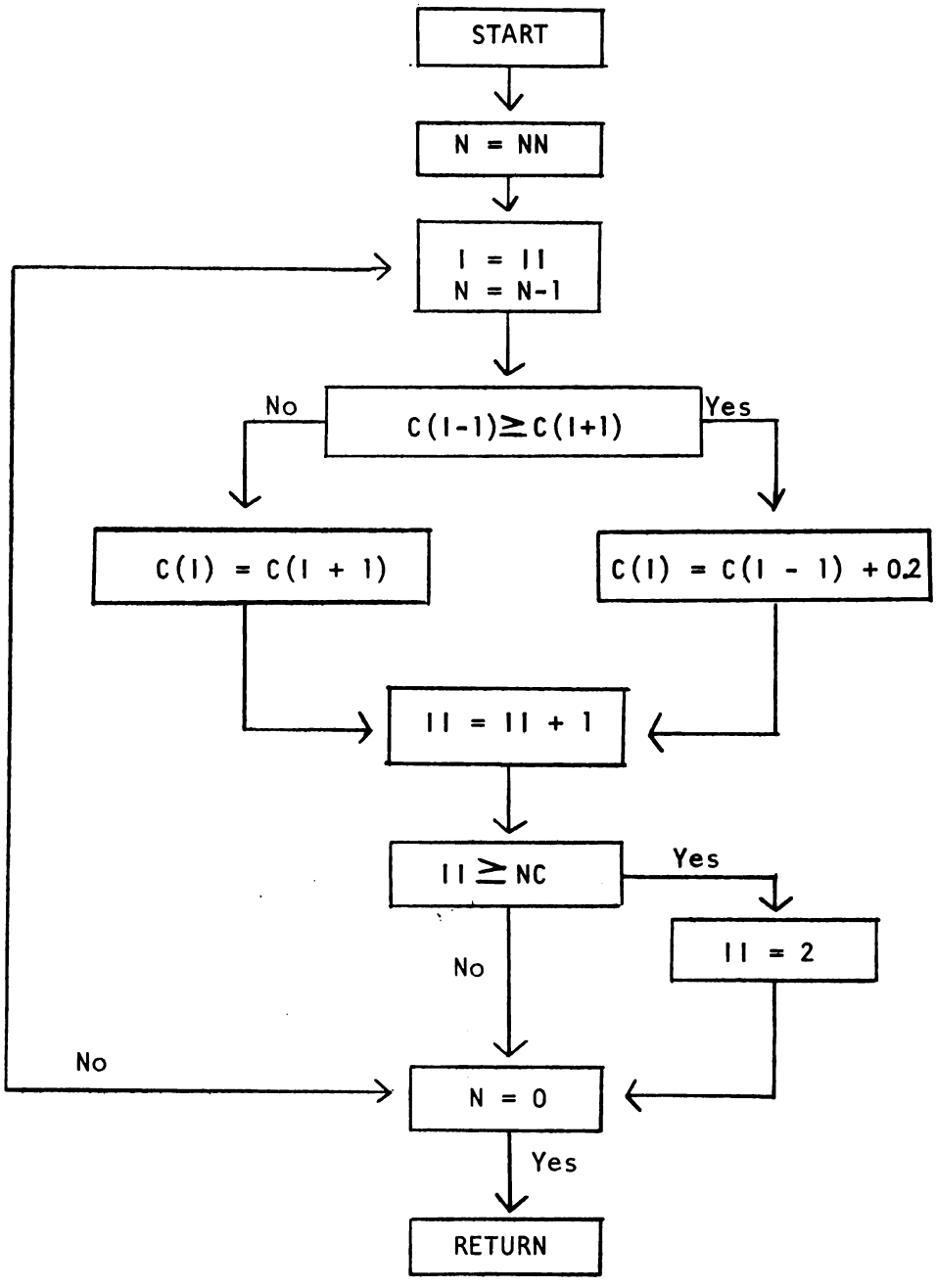
C (3) refers to clock 3

CCF (2) refers to the time a customer finished service at station 2

CCB (3) refers to the time a customer can begin service at station 3

Source: Marie Emma Knickrehm, "Digital Computer Simulations of a Cafeteria Service Line," Microfilm of Doctoral thesis, University of Wisconsin, 1962, p. 94.

EXHIBIT 6.--Flow diagram for subroutine "move"



"N" refers to the number of times the cycle will be executed each time the subroutine is called

"I" refers to the position of clocks being compared

Source: Marie Emma Knickrehm, "Digital Computer Simulations of a Cafeteria Service Line," Microfilm of Doctoral thesis, University of Wisconsin, 1962, p. 96.

Problem
M. S. 1964

Marston, Linda May

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