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A study of administrative data processing at the U.S. Naval Postgraduate School

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A STUDY OF ADMINISTRATIVE
DATA PROCESSING

CAROL A. ADSIT AND ROBERT A. NELSON

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AT THE

U. S. NAVAL POSTGRADUATE SCHOOL

* * * * *

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and

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by

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Lieutenant, United States Navy

and

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Submitted in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE
IN
MANAGEMENT (DATA PROCESSING)

United States Naval Postgraduate School
Monterey, California

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ABSTRACT

Administrative uses of the School's computer system have been developed as needed over a period of years. Frequent overloading of the computer facilities is occurring more and more frequently, and a sizeable increase in the number of students is expected. Therefore, a more efficient system is considered desirable.

Present users of the system were interviewed and their functions described and flow diagrammed.

Other educational information systems were investigated for possible application at the Postgraduate School. A number of differences between this School and other civilian institutions and several problem areas were revealed in this study.

It was concluded that a common data base of information on all personnel connected with the USNPGS would be feasible and would eliminate much duplication of effort in present administrative offices. It was recommended that this common data base be explored further, and that additional research be done on other applications of educational data processing.

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

Originally, computers were installed in universities solely for
education and research in computer technology. However, in recent years,
there has been a steady expansion of computer use for administrative needs.
The computer is now being used by a number of universities and educational
institutions in administering their whole program more effectively and
efficiently. Next to defense, education is the largest single enterprise
of our economy. Many problems in educational administration are similar
to more general problems in information management, and therefore, lend
themselves to data processing applications.

Statement of the problem. It is the purpose of this study (1) to
examine the present administrative use of the computer systems at the
U. S. Naval Postgraduate School; (2) to record and document the present
system; (3) to determine the problem areas involved in considering the
development of a new system; and (4) to present some conceptions of what
should be included in a new system.

Importance of the study. Administrative usage of the School's
computer systems has been developed on a piecemeal basis over the past
four years, with little planning or investigation towards an over-all
system to perform the administrative functions now deemed necessary.
Perhaps the time has come for consolidation of these various demands.
Aside from the actual computer programs, there is little recorded

documentation of those tasks done by the computer and how they relate
or contribute to the other work of the office concerned.

Although there are a number of administrative users of the computer
facilities, most of the available computer time is taken up by students
and faculty working on class assignments, theses, and research projects.
Saturation of the School's facilities is occurring during more and more
frequent periods. This problem also affects the administrative functions,
and the development of a more efficient and effective system is considered
desirable.

Before developing any new system, there must be a determination of
present methods and procedures, even though some may be of minor im-
portance. This study, then, is significant in that such an analysis is
the first step in the evolution of a new system.

Assumptions and Limitations. The following assumptions were made
before beginning the study. (1) Other similar institutions have de-
veloped and utilized educational information systems successfully;
(2) there are, however, significant differences between the USNPGS and
other universities and institutions; and (3) that in considering the
development of a new educational information system, no restriction
would be placed on the type of computer system to be used.

Also, several limitations had to be acknowledged: (1) that there
is a paucity of information available on educational applications of
data processing; (2) that the School's present computer system must be
considered in any immediate plans; and (3) that staffing to implement
any major changes recommended by the study is limited.

Organization of the remainder of the thesis. Chapter II is a review of the current literature in the field of educational data processing, with emphasis on those areas which might be applicable to the USNPGS. Chapter III has a general discussion of what is meant by the 'total systems' approach, and what is involved in a management information system. The method to be employed in the study of a system, and how it was used in this study is contained in Chapter IV. A concise summary of the administrative uses of the computer at the USNPGS is recorded and documented in Chapter V, and Chapter VI is a discussion of the problem areas involved in developing a new system, including ideas as to what should be incorporated in an educational information system at this School. Chapter VII contains some conclusions and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

While the number of applications in educational data processing
has been increasing in the past five years, not a great deal of in-
formation about them has been published. However, a few of the more
important contributions will be summarized here.

In January of 1965, the report of a study conducted by the
System Development Corporation entitled Application of Electronic
Data Processing Methods in Education was submitted to the U. S.
Office of Education. A portion of that report was a chapter "Appli-
cation of Computers and Information Processing Systems in Education."
This paper gives some background information pertinent to the subject
in general, and then provides brief descriptions of actual applications
in three categories: educational information systems, research, and
computer-based instruction.

Educational Information Systems have been successfully es-
tablished in many states and regions, among them New England, Iowa,
Chicago, California and New Jersey. Most computer applications in
schools are an outgrowth of specific school information-handling
problems. The computer is finding application in general business
accounting--the financial and property accounting of all school
business; student accounting--the processing and record-keeping
necessary to guide, regulate, and record student activities; general

administration--the over-all regulation, direction, and control of students and employees based upon the policies and practices specified by local district, state, and national educational systems; and school instruction--the presentation to students of programmed curriculum materials, and the rapid retrieval of documents and reports for instructional purposes.[1]

Since most of the educational information systems developed thus far have many functions in common, only one such system will be described in any detail. The following summary is extracted from the SDC report "Application of Computers and Information Processing Systems in Education."

TIS, or Total Information Service, developed and operated by the Bureau of Data Processing of the Chicago Board of Education, is believed to be the largest and most sophisticated EDP system in any school district; utilizing three IBM 1401 computers, one IBM 7074 computer, and a professional staff of 83, which includes 35 system analysts and computer programmers. The equipment is used in around-the-clock operations, with teaching and research applications scheduled during the day, and administrative applications at night.

A recently-delivered, optical reader unit will provide a means of reading class lists and other pupil records into the system. Unlike the optical scanners which recognize the presence or absence of marks in

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[1] John F. O'Toole, "Applications of Computers and Information Processing Systems in Education," (Santa Monica, California: System Development Corporation, 1965) SP-1980, pp. 12-13.

predetermined positions, this reader converts typewritten and other printed materials into coded input to the computer. An example of optical scanning use is in school attendance reporting. Over 20,000 class rosters containing the names of over 600,000 children will be prepared every five weeks. These rosters, in multiple form, will be sent to the classroom. A teacher's only responsibility will be to mark the absence or tardiness on the document. Students leaving the class will simply be crossed out with a pencil. Names of new students will be typed on the list by school clerks. When the rosters are returned to the computer center, they will be read by the scanner, files updated, and revised lists produced.

All development is being planned as a part of a total information system. The key is the development of an organization record for every facility, whether it be a school, a central office department, or a warehouse unit. The organization record is built up from factors such as the purpose of the room, the qualifications which a teacher must have to teach the subject, the availability of additional support with respect to counseling, libraries, adjustment teachers, etc. As day-to-day transactions in finance, personnel, materials, truck schedules, or student information are performed, data flows across the organization record so that it may be kept up to date.

The total system applications are grouped within six major categories: (1) budget and finance, (2) personnel and payroll, (3) materials, (4) student accounting and student scheduling, (5) computer education or instruction in the computer sciences, and (6) research.[2]

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[2]Ibid., pp. 16-17.

Research is continuing in the development of educational information systems and further reports are expected.

In May, 1965 the 10th College and University Machine Records Conference was held at Michigan State University, and the Proceedings have been published. Numerous applications of educational data processing by individual institutions were presented, some of which were quite detailed with exhibits of inputs and outputs, while others provided only general descriptions of computer use in administrative functions. The schools varied in type of equipment used; a few used only EAM equipment; others had quite extensive computer systems, and one small college used a service bureau for its data processing requirements.

Applications presented ranged from the processing of student registration data, scheduling of classes, admissions procedures, grade reporting and test scoring, budget distribution, food cost inventory and payrolls, to gift accounting and alumni information.

One area of particular interest, that of Grade Reporting using mark-sensing equipment, was discussed by several schools. The method used by the University of New Mexico utilizing the IBM 1230 Optical Mark Scoring Reader will be described briefly.

From registration data, a Faculty Grade Sheet is prepared with a mark-sense position for each of ten grade status codes (A, B, C, etc.). The grade sheets also include each student's name, his student number and college, and the number of credit hours for which he is enrolled. Other pertinent information on these sheets include course title, the instructor's name, the department abbreviation, the college code, and the sheet reference number. The instructor records each student's grade in

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the appropriate space opposite his name.

As the Faculty Grade Sheets are received in the Registrar's Office, they are edited visually and put into proper order by sheet number. When all of the completed grade sheets have been submitted to the Registrar, they are forwarded to the Data Processing Center for processing through the IBM 1230 Optical Scorer. This machine will sense a predetermined configuration of pencil marks on specially designed sheets the size of standard typing paper.

As each sheet is scanned by the IBM 1230, a Grade Reporting Card is punched; one card for each grade sheet of 35 student grades. The cards are edited, by both manual and computer means, and then actual posting of grades to the tape record is accomplished by the IBM 1401 computer. After all corrected grades have been added to the updated Class Tape File, Student Grade reports may be run. This report includes such information as the student's name and address, his parent's address, all of the courses he has taken during the past semester, a grade for each of those courses, and his grade point average for the semester. The printing of the Grade Reports is done on the IBM 1401 computer.

The Class Tape File is also used as a basis for class lists that have the final grades posted to them, and serve two purposes: they become the permanent historical records in the files of the various departments, and they allow the instructors of the courses to verify that the grade on record is indeed the final grade they assigned to the student.

It is apparent that there are certain savings. Keypunching time and expense is virtually eliminated; peripheral equipment, that might

be tied up for long periods of time by another method, are free to be used on other jobs. Perhaps the most obvious time saving is realized in the initial step of processing. At the rate of 1100 sheets per hour, the IBM 1230 can record in punched card form over 38,000 grades per hour. The system itself is relatively simple and permits rapid posting of grades to the student files. Experience with other methods, such as keypunching cards, has convinced the University of New Mexico that the method of reporting grades using the IBM 1230 Optical Mark Scoring Reader has sufficient advantages to warrant consideration by other schools.[3]

Another application which was presented by several institutions was that concerning scheduling. Many programs have been run by numerous universities and colleges but many have yet to be proved successful. The following summary of the system used at Washington State University is extracted from the Proceedings.

After five years of research and study, the Computer Sectioning System was successfully used in scheduling 8,992 students for the fall semester 1964, and 8,608 students for the spring semester 1965. Students registered from Wednesday noon until 3:00 p.m. Friday, at which time student course requests were recorded on magnetic tape and the sectioning began. By 9:00 a.m., Saturday, student schedules were ready for distribution.

There is more to automated scheduling, however, than just sectioning the students, but the manual sectioning operation, which required the

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[3]Jack A. Feise, "Grade Reporting Using the 1230 Optical Mark Scoring Reader," 10th Annual Machine Records Conference, 1965 Proceedings, Vol 1, pp. 127-145.

services of 150 faculty and 70 staff members no longer exists. The scramble for preferred sections and courses has been eliminated. The struggle to keep sections balanced has been eradicated.

The program generates complete or partial schedules for the student, and a rather extensive set of decision rules is necessary as well as a substantial volume of housekeeping. Since the program tries 5,000 times to generate a usable schedule, partial schedules are kept to a minimum. The most troublesome and expensive area of computer sectioning is input preparation; one Mark-Sense Class Card is marked for each course request made by the student. Students average about seven requests each, and the most common error is marking too lightly on the mark-sense card.

One of the most significant products of the sectioning system has been the "Course Request Report." This is the first time that the university has actually known the request pattern for courses. Another benefit is the previously unachieved balancing of sections. Information on space utilization is now in usable form which will be of material aid in future planning. By carefully analyzing the reject files, especially the conflicts, the university is gaining a much better understanding of what is required to build a more flexible and efficient time schedule.

One of the goals of the university is the machine generation of the annual time schedule. While the optimum schedule is a long way in the future, a new tool of sectioning programs is available to help pave the road. With this tool, a wide variety of experimental time schedules are available for research without waiting for registration time.[4]

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[4]Martin Faulkner, "Some Thoughts on Computer Sectioning at Washington State University," 10th Annual Machine Records Conference, 1965 Proceedings, Vol 1, pp. 494-506.

A monthly newsletter, Data Processing for Education, is published by American Data Processing, Inc., as a service for those in the educational data processing field. In addition to giving a brief summary of recent events, each newsletter discusses one or more topics of special interest. Two recent applications thus treated are of interest and are presented below.

The first article deals with the Preparation and Scoring of Examinations by Computers. The following summary is extracted from the newsletter.

Too many instructors waste valuable time and energy in scoring objective type examinations by hand, and in colleges and universities with large classes, clerical and secretarial staffs waste considerable time in stenciling alternate examination forms. Not only can a campus computer do both jobs in a shorter time and for less money, but the computer printout of the test results are more meaningful and useful to the instructor, and these results can be used to improve the quality of teaching in the college and university.

Computer-scoring of objective type tests involves the use of "mark-sense" cards, specially designed punched cards on which students indicate their answers by writing in the provided spaces with special pencils. In this example, answer cards were designed with space for 50 answers, and color coded for correlation with the right form of the examination.

When objective type examinations (either multiple-choice or true-false) are hand-scored by an instructor, he generally has only the

student score--raw and percentage scores. The computer, however, pro-
vides the instructor with considerably more information, which can
assist him in grading, test evaluation and construction, and even
teaching. Among the printout data he receives are: (1) student's
name and number, the number of questions answered correctly, the
number wrong, number omitted and the percentage score for each student;
(2) the mean score and standard deviation for the class; if more than
one section takes the same examination, the printout includes a com-
posite mean and standard deviation; (3) a frequency distribution and
cumulative frequency by score intervals for each section; again, if
there are several sections, a composite series is produced; and (4)
an item analysis indicating by question, the number of students selecting
each choice, the correct answer to each question indicated by an aster-
isk, and the percentage of all students who have responded correctly
to the question. An item analysis is performed for each class section,
and in multiple-class common final examinations, an over-all item analysis
for the entire group is printed out and prepared as well.

This system is currently in operation at Long Island University.
It is estimated that approximately 550 hours of scoring time were saved
during the first four days of the final examination period in the spring
of 1964 when some 15,200 student mark-sense cards were scored by the
computer. Also, if done by hand, instructors would not have had the
item analysis, a frequency of class grades and the composite score and
standard deviation statistics. It is felt that the time and cost spent

to develop the program has been worth it.[5]

The second article, "Flying a College on the Computer," deals with optimum class scheduling in planning a new junior college. Dr. Tirell, author of the article, maintains that new buildings, designed with the optimum number and sizes of classrooms and run on an efficient schedule, can show a large increase in the number of students taught per square foot of building area. Use of an electronic computer to digest the best available data and to simulate the operation of a building or a campus has increased the possibility of arriving at an effective solution. By changing the number, size, and seating arrangements, of proposed classrooms in this simulation and studying the effects, far more effective space use can be determined than by manual methods.

A master schedule for the operation of the campus was needed, and it was indicated that the Massachusetts Institute of Technology's program GASP (Generalized Academic Simulated Program) would work.

Briefly, the course choices for 4,500 students (60 percent in college transfer and 40 percent in technical programs), number and size of rooms planned, faculty proposed, and various time patterns, were used as input. The computer went through the thousands of possible combinations in about five minutes and started printing a schedule. Twenty-five minutes later the room utilization, including each faculty member's schedule, each student scheduled, the percent of rooms used,

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[5]Dr. Harold J. Highland, "Preparation and Scoring of Examinations by Computers," Data Processing for Education, Vol. 3, No. 11, pp. 1-4.

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the percent of seats used, and other pertinent data was printed out and available for analysis.

After review, the number of lecture halls, classrooms, and faculty would be varied and the program run again. This was done twenty-seven times. After final review, the architects were provided with educational specifications for eighty-five spaces, seven less than the number they had considered unacceptable earlier. But the computer simulation showed it was possible. The potential savings are enormous.

This program can also be adapted to determine room and seat utilization, and initial and final faculty requirements. The significant benefits from such simulations are obvious and warrant further investigation.[6]

These six examples of data processing in the educational field, are considered representative of the variety of activities today. Other sources of information of potential benefit include several IBM publications: University-College Information System, in which a general educational information system is described, and Student Data Processing System at the University of Illinois, and General Information Manual, IBM Data Processing Machines at the University of Oklahoma.

Additionally, the Department of Audiovisual Instruction, of the National Education Association of the United States, published in 1964 a Monograph, entitled "The Automation of School Information Systems," which is a series of short articles on a wide range of school applications.

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[6]Dr. John E. Tirell, "Flying a College on the Computer," Data Processing for Education, Vol. 3, No. 9, pp. 1-5.

These articles are the result of a workshop sponsored by the American Educational Research Association, and are recommended as valuable background reading.

Further sources of information are supplied in the bibliography.

CHAPTER III

MANAGEMENT INFORMATION SYSTEMS AND THE 'TOTAL
SYSTEMS' APPROACH

The terms 'management information system' and 'total systems'
appear in almost every piece of current literature pertaining to data
processing systems. Computers play a central role in the development
of these systems, and perform various functions such as the evaluation
of facts and conditions, both known and unknown, comparing actual per-
formance with planned operations, keeping track of records and data
pertaining to a multitude of details, and so on. What binds the sum
of the parts together as a whole is a system.

An operating information system consists of data elements such as
a person's name and file number, a stock inventory number, the number
of classrooms in a building, etc. These data elements are formed into
files of varying kinds, which give in one place all the information needed
about a particular subject or area. Data in and of itself, however, is
meaningless. It must be combined in its various aspects and made avail-
able to those who must have it to operate effectively, for information
only takes on significance when considered in relation to previously
accumulated information and prior plans.

Information is generally classified as operating information which
includes working documents, decision-making data which involves the
evaluation and comparison of alternative courses of action, or performance

measurement data which determines what progress is being made. The basic input data will be combined, modified, merged, consolidated and analyzed so that the information needs of every level of the organization are met in a timely, accurate, and useful manner with minimal duplication of input data.

A system provides myriad patterns of interlocking data and information flows. The total system for an organization, which is influenced by the particular environment in which it is being considered, must be broken down into major systems, and these into minor or sub-systems. A major system may be said to affect the entire structure of an organization where a sub-system is usually limited to the part of the organization. In the past, too much stress has been placed on specific applications, and not enough on the interrelationships of systems. Operations, whether of a business or an educational institution, consist of a set of closely related sub-systems, and the integration of these sub-systems is the key to the effective and efficient operation.

Sub-systems may operate independently or together; however, the contribution of the sub-system to the total system must be considered. The information output being generated by a sub-system frequently can be tailored to fit directly as information input to related sub-systems. The importance of a thorough understanding of data usage is obvious. Information flowing between the component parts of an organization represents an over-all information system, just as an organization is a structural whole.

Total Systems. The phrase 'total systems' came about several

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years ago and means different things to different people. A few of the numerous definitions to be found are as follows:

> We define a total system as "that system which provides the maximum pertinent information that management or operations 1 require to effectively discharge their assigned responsibility."

> This is nothing less than the complete monitoring of the business enterprise by a computer, or group of interconnected computers; ...and the limiting of human control to such functions as setting over-all objectives and reacting to such totally unexpected situations as earthquakes or wars.[2]

> From a system man's standpoint, a total system may be the total project on which he is working, including all necessary interrelationships with other functions.[3]

> To some, a total system is the total corporate information system, in which all transactions and records are stored, and from which selected information can be withdrawn according to established rules.[4]

> To some, a total system involves the mechanization of a "goal-oriented activity": some large segment of an enterprise, consisting of logically related operations which cut across departmental lines, aimed at filling one of the company's major operational goals.[5]

It is apparent that from these definitions the phrase 'total systems' means more than an integrated system. An integrated system suggests that information developed for various applications is maintained in certain centrally-located files, and that these files are available to all those

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[1]Richard W. Graham, Jr., "Total Systems Concept," _Management Technology_, Vol. 4, No. 1 (June, 1964), p. 1.

[2]John Dearden, "How to Organize Information Systems," _Harvard Business Review_, (March-April, 1965), p. 66.

[3]"Get Set for Total Systems," _EDP Analyzer_, Vol. 1., No. 2, (March, 1963), p. 1.

[4]_Ibid._

[5]_Ibid._, p. 2.

who need any or all of the information stored in these files. For example, several functions of a manufacturing company, such as customer billing, stock inventory, sales transactions and records, manufacturing costs, customer orders, etc., may have been automated individually, one at a time, with perhaps much duplication of data. An integrated system would bring together these various physical files and processes into one main file depository, where all facets of the organization would have access to the data contained therein. The over-all view of the organization and its goals and objectives may or may not have been an important factor in the integrating of the parts of the system into a whole.

On the other hand, the goal of a 'total system' would be to bring together in a single file all information pertinent to the organization, e.g., personnel, customer billing, stock inventory, etc., records would be stored together on one medium, tape, disk pack, etc.

However, there have been objections to this term 'total systems'. John Dearden voices one common feeling that

> First, the entire information system of a company is just too large and all encompassing to be a meaningful and useful classification.
>
> Second, the development of an information system requires such different kinds of skills that the term has little use in helping management approach the problem of organizing for the development of effective management information systems.[6]

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[6]Dearden, op. cit.

Nevertheless, the majority of sources consulted were in favor of the concept with slight differences. For the purpose of this study, a 'total system' is considered to be a collection of component sub-systems, e.g., personnel information, inventory of plant property, scheduling, etc., operating together to accomplish the defined purpose of the organization, and that in the development of these sub-systems, the over-all goal of the activity has been kept in focus.

Management Information Systems. A management information system is a specification of the content and format of information that will best satisfy the operating, planning, directing, and controlling needs of the organization. It will provide all the appropriate data, and only the appropriate data, to enable those who manage to do so effectively and efficiently. Of course, the system must include adequate controls over the accuracy of input and processing with provision for correcting the effects of errors in the data introduced into it, and for adjusting the controls as required by changing circumstances.

Objectives. The first step in system development is that of establishing objectives. For a management system, they are numerous and any one system cannot hope to accomplish all of them, nor should any one system try. There is no universal set of factors which can be used as a single reference in planning a management information system applicable to every organization. However, the following list of objectives, culled from many sources, should provide some guidelines.

1. Files should be consolidated so that operations may be condensed, and duplication of information between files is eliminated.

2. Information that is gathered, summarized, and presented must be effective; in other words unimportant information should be screened out.

3. Information inputs should be reduced to a minimum. Aim for an integrated reporting system, one that aids the processes of planning and control yet satisfies any legal and governmental reporting requirements.

4. Along with number three, data should be entered in as elementary a form as possible, convenient for direct processing of as many of the required output documents as possible.

5. In a computerized system the number of runs should be reduced in order to save time and money. Try not to post information to the files only, aim for all the required outputs at the same time.

6. Improve information flow between various functions of the organization, bringing into focus critical factors which may have been priviously overlooked. However, low-value exception reporting, though tempting, should be eliminated.

7. Information received from the system should facilitate decision-making, keeping all levels of the organization informed with the same information, allowing for maximum communication, and giving a wider range of current factual data and alternatives.

8. There should be effective integration of both the manual and computer aspects of the system, allowing the flexibility needed to furnish information not regularly required.

9. The system should aim to accomplish the organization's purpose and mission, emphasizing the organization vice one function's objectives.

10 And last, though by no means least, an objective should be to

exploit the capabilities of the computer to the fullest extent.

Approach and Analysis. Before determining what approach to take
in developing a total management information system, a thorough analysis
of the current system and its environment are necessary. How to go about
this analysis is the subject of Chapter IV. As has been stated, any organi-
zation can be analyzed as an over-all information system composed of inter-
related and integrated systems and sub-systems, and an understanding of
what is entailed in the system provides guidance in formulating speci-
fications for the new or re-designed system, and reveals any
major problems involved.

A number of items should be considered in the analysis; the more
important ones are enumerated below.

1. Acquisition of source data and its origination.

2. Data transmission to the computer.

3. Conversion of information into a computer processing format.

4. The nature of information flow between divisions and levels in
the organization including data characteristics and elements, and de-
cision-information relationships.

5. Frequency and output format of routine reports, including
descriptions of them, and the ways in which they are used.

6. The degree of uniformity in practices, policies, procedures,
and reports throughout the organization.

7. Management information requirements, and how they are being met
by the current system.

8. What data is available, and in what form, where located, and

how long it is to be maintained.

9. Capacity of current system to accomplish objectives of the system, and its flexibility.

10. Data-information applications that demand improvement.

11. Specific restrictions affecting the current system.

There are several approaches toward the development of a total information system, but three stand out as being the most practicable. The first of these is the step-by-step approach which is slow, usually taking several years to accomplish, but which can and has worked. Here various functions are automated one-by-one, as the need arises. Periodically, what has been converted must be consolidated so that ultimately the total system is complete.

The second approach is referred to as the consolidated file approach. It brings together all pertinent information about some one thing in one record so that when decisions are made on a course of action, they are based on the complete picture, and not a partial one. An example of a consolidated file is an inventory file, containing the total inventory of a warehouse, or a customer file, including all the customers serviced by the organization.

Mechanizing a specific goal-oriented activity for a single product is the third approach. This can also be interpreted as mechanizing toward a key element in an organization, for example, establishing a common data base of information on all students, staff, and military personnel connected with the School. Any approach will involve the determination of the fundamental elements and of the relationships between them, and second, the restructuring of the elements and the

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relationships into a new entity to meet the pre-established set of objectives.

Key Factors. Before elaborating upon the characteristics and requirements of an information system, certain over-all factors need to be considered in its development. The information needs of the organization must be translated into specific parts of the information system, which will involve defining and evaluating alternative courses of action before making a final decision. If a system is already in effect and is being re-designed, then the characteristics of the existing system for each function and the organization as a whole should be compared with those of what the new system is supposed to entail, and the degrees of similarity and difference noted. Additionally, an estimate should be made and evaluated concerning the degree to which the new organization will be integrated into current operational activities.

At this point, the scope of a total management system should be considered. There are three basic functions.

1. The production or work flow, which may be represented by a network of stations where work is done and by paths along which work or materials move.

2. The decision network with an associated organizational structure. Decisions are either required to make the work flow or required by the work flow.

3. The information system, which is related to internal and external information flow:

   a. The internal information network governs the flow of information between work and decisions.

b. The external information network is related to the (organization's over-all)...operations and is connected only to the decision function.[7]

Also, the basic functions of a total management information system should be examined. There are, briefly, to predict, to compare prediction with actual results, to produce or show the deviations between the predicted and actual results, and to plan, organize, control, and execute. It should be remembered that much of the information used for control is also used for planning and operations since plans for the future are ordinarily guided by past events, and operations are set to conform to plans.

All methods of originating and transmitting data should be evaluated so that any new system will not be unduly influenced by the one already in use. The cost of compiling information has to be related to its ultimate value, and this value is characterized by three things: intangible values, which frequently come to the foreground only to reinforce a decision to adopt a new system; cost outlay, determined by accuracy, timeliness, capacity, load, selective or standardized processing, and the reporting plan used.[8] The cost might be quite substantial, and if certain information is used only occasionally, the cost may not be worth it.

Another important factor to be considered is whether random-access or sequential storage is needed. Sequential storage means that the data

[7] Rocco L. Martino, "Creating a Total System for Management," Case Studies in Computer-Based Management (New York: American Management Association, 1963), p. 7.

[8] Robert H. Gregory and Richard L. Van Horn, Automatic Data-Processing Systems (San Francisco: Wadsworth Publishing Company, 1960), p. 356.

elements stored become available only in a "one-after-the-other" sequence, whether or not all the information or only some of it is desired; random access storage means that the time required to retrieve the information needed is not dependent on the location of the information, i.e., direct access to a data element is possible. Random access capability is much faster, and usually more expensive than sequential storage, and this cost must be considered when determining just how convenient and flexible the system must be, and how the method of retention affects repetitive use where necessary.

Understanding the problem as defined is also essential; this includes a realistic statement indicating the kind of system necessary to produce the reports needed which should be based upon data handling procedures. Additionally, the organization's goals and structure and their relationships should be reflected in the system.

Information systems usually serve three different purposes: record-keeping where an individual item of information itself is significant; 'fact recovery' where an individual item is not as valuable as the information extracted from it; and research and analysis where not the individual fact, but some analytic combination of facts from the system is important.[9]

An finally, among the factors to be kept in mind during development are the size of the files, the frequency with which information is sought

[9] Joseph Becker and Robert M. Hayes, Information Storage and Retrieval (New York: John Wiley and Sons, Inc., 1963), pp. 236-237.

from them, and the complexity of the questions asked. In any information system, output should be considered secondary to development and definition of the information file, and secondary to the definition of the input which is to update the file.

Requirements and characteristics. There are many system requirements and characteristics of a total information system that can be enumerated. The following considerations seem to be representative.

1. Top management support for any system is required for success, as a total system is bound to cut across departmental lines.

2. Middle management support is also essential, and this is usually gained from the users participating in the planning and design of the system.

3. Basic policies of the organization and any statutory regulations must be known.

4. Basic sources of data must be established and relationships between types of information determined, including what the various levels of decision-making are. Input to the system is simplified to reduce human error, and wherever possible, there is a single-time input of any specified data element.

5. The specific needs of the user must be known and the total data requirements defined in terms of what is needed and when it is required.

6. A total system is required to be selective--irrelevant information is eliminated and only that data which is needed is included. Emphasis is on those reports which give a qualitative vice strictly quantitative analysis of information flow. These are prepared rapidly and economically

on a desired, periodic, or as required basis.

7. "Interacting variables--one of the computer's most important features is its ability to perform arithmetic and logic operations at tremendous speed. This feature is required for solving problems which have a number of interacting variables."[10]

8. Large amounts of information can be handled quickly and accurately thereby allowing more comprehensive coverage and more current, up-to-date information reflecting important recent conditions.

9. Speed--as much as is needed, when needed, and as justified in determining the value of the information, not only in computation but in response to an inquiry.

10. Capability must be provided for rapid reconstruction of input data when discrepancies or errors are detected, so that audits can be made to isolate and identify the error and at the point at which it occurred.

11. The information must be nearly one hundred percent accurate as many decisions and courses of action depend upon it. If the input is consistently correct and in the proper form, the reports received should not only be more concise, but extremely reliable as well.

12. Flexibility must be present in the system for management problems and needs change continually and the system must be able to cope with them without extensive re-design.

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[10]John Dearden, "Can Management Information be Automated?" Harvard Business Review (March-April, 1964), p. 130.

13. Priorities of processing must be established and followed; this is a function of the needs of the user. Additionally, a time schedule for production must be maintained so that the system will be able to meet the demands placed upon it.

14. The responsibility for developing and maintaining the data base for the information system must be assigned to a central data-processing group. Initially, a good project leader and systems analysts are required to develop the system. A precise definition of the problem and goals of the organization must be followed by the group in designing the system. Once the system is developed, however, it should not be set off under some other function and neglected; for success in operating a total information system, a separate group of personnel is required.

Criteria. The more performance criteria that can be established, the better the evaluation will be of the operating system's effectiveness and efficiency. Emphasis should be on the measurement of effectiveness, and this can be accomplished with definitive performance requirements.

The degree to which the system continues to meet the operational requirements of the organization is one way to measure its effectiveness. The question can also be asked, is the system accomplishing the objectives of the organization? There should be a feed-back of information required by internal controls built into the procedures to assure validity of results and to check whether there was proper adherence to procedure and policy.

Is information being delivered when and where it is needed? Is it

usable and relevant? Is the system adjusting to any sudden increased demands made upon it by operating personnel? And finally, is the system fulfilling the mission for which it was intended? If these questions can be answered positively, then the system is functioning as it should.

Problems. Many problems and pitfalls are encountered in developing a new system. Perhaps the most common source of complaint from system developers is that they do not have top management support. This is one of the largest causes of system failure and its importance cannot be overemphasized. Top management indifference is just as bad. Unless management takes an active part in defining the objectives of the information system, and the people developing and implementing the system have the proper responsibility and authority to the job, the chances of achieving a completely integrated system are slight.

Failure to define all elements of the systems-data-processing program is another pitfall to be avoided. There is no excuse for poor and inadequate planning, failure to formulate specific objectives and policies, and lack of definition of the scope and responsbilities of the data-processing function and other departments. This all leads to poor, if any, communications between the systems developers, operating personnel, and programmers.

Then there is the problem of the growth of reports--for two reasons. One, users find out the range of information available in the system and they feel they need more and more data; and two, even though the users may have helped to plan the new outputs and agreed to them, they may not like being restricted by them and they may ask for reports to be run as

they used to be. The key is to demand that all requests for information be thoroughly justified.

Insure that the system study is neither too short nor too involved with detail. Aim for a happy medium. It is best to start out on a broad level and then narrow down the attention to the goal-oriented activities of the greatest importance.[11]

There is a false assumption that anything being done electronically on a computer is being done in the best manner; the computer is a systems tool, not just another office machine. An automated system may not be the best, nor a manual system the worst; what may be the most efficient system is a combination of the two, and hence, the manual aspects of the system should be given as much attention as the mechanized ones.

While it may not be feasible to develop a new system "in house," be wary of systems specialists who are brought in. They are working under a handicap and may fail to grasp the organizational relationships or the purpose of the information system. They may be concerned too much with specific operating problems rather than with the over-all system.

If shifting from a manual to a mechanized system, it must be insured that unnecessary data and reporting procedures are not carried over by default. And in this same line of reasoning, care must be taken not to provide one level of management with the information designed for another. Reports often do not match with organizational responsibilities;

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[11]EDP Analyzer, op. cit., p. 7.

in other words, they are receiving information that is not needed, and not receiving what is required.

Insufficient staffing to do a decent job is another failing. The size and nature of the development of the system plus its maintenance job required to keep the system current is often under-estimated. Since the cost of development is considerable, it is best to protect it with proper staffing.

While this chapter has been concerned primarily with the development of the information system, it should be noted that choosing the wrong computer and equipment will not permit successful implementation of the system. On the other hand, do not choose the computer first and then design the system. This results in limited success at best.

Every effort needs to be made to work out the conflicting personal opinion and interests which do more to retard the progress of the development of the total system than most any other factor. And the project leader has yet another problem, that of insuring the compatibility of sub-systems within the total system. He must understand the problem and forget to look at the system as a whole.

Naturally the education of those who will be connected with the system in one way or another is of paramount importance. It is essential to keep all operating departments, and all management personnel informed as to what is being developed and why. Also, it must be clearly understood by all what can and what cannot be done by the computer.

Summary. A total management information system exists, primarily,

for two reasons: to "make" a decision, or to cause something to happen when a decision has been made. The computer and the people who operate it are only as effective as the information system itself.

Any such system must be preceded by a study of the present methods, and the changed or new goals. It takes time to develop a good system and to implement it. Too much should not be expected too soon!

CHAPTER IV

SYSTEM STUDY

A system study is important for two reasons. First, any new system must, at the very least, perform as well as the present system. Therefore an understanding of the present system becomes the logical foundation for the design of the new system. Second, an understanding of the present system is also needed to obtain a clear picture of elapsed times, sequences of operations, unit operation time, operating volumes, and operating costs.[1]

General Considerations. In any real life situation, objective recording of observable actions is requisite to understanding the process. A statement of systems boundaries is dependent upon an ability to define the system under study. This becomes the goal of the initial investigation into the nature of the system. A knowledge of the system will follow from an understanding of the following items.

1. Activities which are associated with the on-going process.

2. The inputs which are processed in the system activity.

3. The outputs which are obtained as a result of system processing.

4. The way in which the on-going process is controlled.

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[1] IBM Data Processing Techniques, (IBM Technical Publications Department, White Plains, New York), 1963, p. 3.

5. The errors, deviations, exceptions which have been marked as system malfunctions.[2]

A statement of the boundaries will, after determining the objective of the system, place limits on the systems to be studied. A boundary, in the systems sense, restricts the scope of the study to a size commensurate with the time available for investigation and the amount of detail necessary to understand the process. It is possible to view the present system in many ways and change the boundaries accordingly. Management's view would tend to relate the present system to the organization as a whole and management would tend not to see it as an operating unit filling a variety of day-to-day needs. The users of the present system would tend to think in non-organizational terms, perhaps only looking at one or two special functions performed for them alone. These statements are not necessarily contradictory, they only emphasize the range of definitions possible.

The division into sub-systems create an area of manageable size for investigation. Systems which include many sub-systems will, in proportion to the complexity of the organization, tend to be less easily managed or controlled. The ability to look at systems and sub-systems from the same point of view, improves the ability of the researcher to maintain uniformity and consistency in the statement of objectives, criteria, and assumptions. This ability improves performance in problem

[2] Stanford L. Optner, Systems, Analysis for Business Management, (New Jersey: Prentice Hall, Inc.), 1960, p. 21.

recognition, problem identification and fact gathering.

What is the existing system? This is the first and sometimes
the most important question in a systems study. It contains
the important objectivity required for effective investigation.
It does not presuppose that there is no existing method for
coping with a problem. The existing method may be malfunctioning
or poorly conceived, but these are precisely the symptoms the
investigator must understand in order to be able to document the
problem carefully.

How does one determine the nature of the existing system?
This is a period of intensive data collection and interviewing.
Basically there are two types of information. The written word
and the spoken word.

The written materials which are pertinent might take the following
forms:

(1) Examples of inputs or outputs.

(2) Examples of file records.

(3) Actual examples of systems malfunction.

(4) Memoranda, letters, notes which may be pertinent.

(5) Other reports, commentaries indicating previous study of
or attention to the same problem.[3]

A good principle to follow is to sample everything of value. Take

advantage of every type of existing information. It is reasonable to assume

that too much raw data is better than too little. It is easy to cast out

the unusable data. On the other hand, it is not desirable to have to hold

up a large part of the study for lack of enough data.

Interview. The spoken word can be very valuable. The organization

may impose certain restraints that will make it very likely that some

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[3]Ibid., p. 32.

things can be learned by word of mouth that will never be found on paper. Thus, there are good reasons for interviewing the people most affected with the problem under study. But some personal interviews can become confusing and time-consuming. Even worse, they can put the investigator off on the wrong track. The title and personality of the person being interviewed can inject a pronounced bias to an interview. The hazards of interviewing only make it more necessary to plan in advance and fit the material collected by each interview into a pattern. Interviewing can take the form of an opinion poll when improperly handled.

If the interviewer has the cooperation and confidence of those interviewed, then this will be the most productive method of securing information about the present system. The role of the interviewer is to obtain specific information. He will attempt to control the interviewing process without cutting himself off from vital information by obstructing an important channel of questioning. He will be forced to make decisions as the interview proceeds as to what line of questioning is valuable, what information is relevant, what data he can get elsewhere with higher reliability, and how much of the data being collected will require other confirmation before being used.

One interview technique is to get the problem in narrative form first, and then follow the leads that come out of the narrative to ask specific questions. The interview should start with mutual recognition of why the system is being investigated. The material to be covered must be preplanned with the idea of keeping the interview within bounds. Sometimes it is valuable to compose a statement which will describe the purpose

or the object of the interview, and to use this as a guide.

During this "get acquainted" phase, some knowledge of the system is necessary to aid in separating facts from opinion. Opinions are revealing and helpful and thus should not be ignored, but they should be labeled as opinion. It is important to interview personnel representing both sides of significant topics. Opinions expressed covering both sides of a particular operation can be valuable. As an example, interview the personnel preparing a report and then from the other side, the personnel utilizing the information in the report. Generally, the investigator wants facts not opinion. However, if opinions which may be necessary or desirable are solicited, they must be treated as such. All levels of personnel should be questioned about improvements they might recommend if they were in a higher position. Be sure to give them credit for their ideas when discussing these recommendations with management. The following summarize some general points on the conduct of an interview.

1. Make personal contact with your subject immediately; keep the contact "human". Five minutes of warm-up before you start will pay off in better cooperation.

2. Describe the assignment briefly so the person being questioned will see his part in the system study; make him feel he is on the "inside"; tell him what your role is; invite him to feel the importance of his role in the study.

3. Have an outline of the material you intend to cover and other pertinent data with you in the interview; use these as a guide to be sure you are getting all the data you came after.

4. Make your notes brief but readable; then promptly write out in detail the information you gathered while the interview is fresh in your mind.

5. If you are making lists or enumerating data, organize the information for logical and easy understanding on separate sheets, noting where to insert the data.

6. Be sure to note the date, the names of the persons in-
terviewed and their titles; head each interview separately
for easy identification, indicate by page number and date.

7. Be sure references to flow charts are clear and unmistakable
so notes and flow charts can be easily associated.

8. If you miss a point and return to re-interview to clarify some
point or wish to gather additional data, be sure it is inserted
properly into the total.

9. The format used for the data should be easy to follow and use
and be along conventional lines of information arrangements.

10. The interviews should be arranged in advance and kept informal,
yet businesslike.[4]

Here are some valuable "do nots" that apply in conducting an in-

terview.

1. Do not interrupt the story to insert your own ideas.

2. Do not let the interview get diverted into paths that are
obviously not pertinent.

3. Do not let blanket statements or broad generalizations obscure
the facts.

4. Do not let half-understood problems go; leave the interview with
a clear concept of the issues.

5. Do not be overpowered by the person being interviewed; be sure
to leave feeling you were the interviewer and not the interviewed.

6. Do not become involved in operational problems or offer solutions
that will distract from the prime purpose of information gathering.

7. Do not ask questions that can be answered "yes" or "no" without
recognizing that the question sometimes will call for an opinion
and not a fact.[5]

File Search. Information about the present system exists in many

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[4]Ibid., p. 34.

[5]Ibid., p. 33.

places, some external to the system, others internal. From the files, all data, current instructions, historical background, accounting data should be verified with personnel who are acquainted with the subject matter. A list of many sources of information can be obtained from the first interview with top management. Sometimes good internal sources of information are the ones most difficult to search because of their constant use. An example of an external source would be systems users files.

Important historical information includes reasons for starting and expansion as well as the growth in physical facilities and equipment and number of employees.

General information about the pattern of growth and major events in the expansion will assist the understanding of the present system. You do not need the complete chronological record of every event that took place in the system development and growth. Concentrate on the major milestones which are usually the result of a management decision reflecting the basic goals of the system.

Factual data about similar systems in operation at other facilities can provide ideas for ways to help management improve the present system. This information will be necessary to back up any recommendation for system improvement. Background information includes material showing important technological developments, comparable statistics on volumes handled for time required, etc.

Structural information pertaining to the present system describes interactions between system users and system resources. This information is necessary to develop a deeper understanding of the present system as

well as to prepare management and other planners for the operational analysis and systems design work ahead.

System design personnel will examine the present system inputs and outputs, for example, for possible duplication of effort by various users. The physical inputs to the system are data for programs, the system outputs are reports. Any existing system and program documentation will be valuable. The value of the service performed for users against a cost of time required of the system is important to determine during the system study.

Other Factors. It is important to keep in mind the future of the system. Management plans for major changes in policy, objectives, volume, procedures, etc., have direct bearing on the system study procedures to be utilized. The information which summarizes the current major policies and practices which directly affect the operation of the system must be analyzed in light of planned or expected changes in the future. While not as basic to the system operation as objectives and goals, they have usually stood the test of time and should be recognized as important current ground rules. Information about plans for expansion, internal changes, future requirements, etc., are what is needed.

In systems studies there are many chances to become derailed or stray from the planned path. One common error is improper problem formulation. Evaluate whether the objective has been correctly stated and is actually the one to be pursued. The really basic problems which may exist within operations in a system are not always obvious. Much time can be wasted tracking down and trying to solve a problem which does not exist or was not the objective of the system study.

Another danger lies in the tendency to concentrate on the solution of problems and lose sight of the problems themselves. In mathematical modeling techniques, for example, it becomes fascinating to investigate all the possible combinations of solutions which are generated by varying the inputs slightly. A study team may become so engrossed that it loses sight of the original problem. As the data is being collected and organized it must be checked and rechecked for the following: (1) objectivity or absence of bias, (2) accuracy, (3) validity, (4) reliability, (5) relevance, (6) completeness and (7) usefulness. This leads to the problem of documenting this data.

The documentation is needed to support recommendations and future phases of study. Here it is easy to say, "Don't collect too much or too little," but this doesn't offer much guidance.[6] Closely related are two other problems; what are the significant areas to investigate and, how deeply should they be probed? It is good policy to hold the study at arms length occasionally and take a good look at the system study to maintain proper balance among events. There should be a good indication of what areas are relevant (and what areas are not) soon after the study is underway. Priority should be assigned to the significant areas on which the most effort will be expended.

The last common failing to be mentioned is excessive ambition or the attempt to cure all ailments in one system study, once parameters of time and personnel have been defined. If problems have been formulated

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[6]IBM Data Processing Techniques, The Method Phase I, (White Plains, International Business Machines Corporation), 1963.

correctly, a careful study plan worked out and followed, and a reasonable number of alternatives evaluated, then this is about all that a small systems study team can hope to accomplish.

The Study Plan. After preliminary background study, the formulation of the study plan can begin. This plan will incorporate many ideas from the general considerations and factors stated previously in this chapter. Any specific investigation will enter some areas peculiar to the organization involved, and may not be covered by general guidelines. Thus, some departure from any set of guidelines is to be expected.

The interview guide is designed to be the framework for the systems study. It assures that certain relevant points are covered with each activity interviewed. It provides a vehicle to display the information gathered in a uniform format and helps to keep all data pertaining to a particular activity together. The goals and objectives specified for the study should also be kept in mind when developing the study plan.

Conducting the study. The above interview guide was used in conducting a study of the present uses of the computer system at the U. S. Naval Postgraduate School. Since the scope of the investigation was to be limited to the administrative users, it was necessary to identify these users and record the relevant details of their requirements upon the present system.

The first interview was with the computer operations personnel, where a list of those using the system was obtained. Records of their requirements of equipment and time were made available. This information

proved very useful when later interviewing the users and comparing such items as the time they felt they were using the computer with the times from the computer center records. For example, a user may feel their runs never require more than one hour. Yet because the run requires that special paper be in the printer for their particular output, computer personnel must stop normal output 20 minutes before the start of this special run to change the paper and another 20 minutes to change back. This detailed information, such as how different users requirements affect the Computer Facility in scheduling various users runs, is important background to be gathered before an actual interview with the particular user. Important questions so developed can be added to the interview guide. It may be that a user's computer runs could be moved up or put off a short period of time to allow the Computer Facility to batch certain administrative runs with similar peculiar requirements to reduce lost time due to some change over process. In this fashion, time lost can be minimized and the existing Computer Facility equipment can be utilized to the maximum.

The systems users were contacted and appointments set up for an interview. At the first contact with interviewees, the objectives of the study and what types of information would be most useful to the study were explained. After the data had been gathered, it was analyzed and presented in narrative form with simple flow diagrams.

The information gathered during the interviews and the figures aiding the narrative are presented in Chapter V. An example of the interview guide appears in Appendix A.

Along with information gathering, samples of source documents, data

cards, copies of printed output and finished reports and documents were collected. Early interviews pointed out some weaknesses of the interview guide. Also the written narrative brought to light some areas of confusion and the necessity for re-interviews. The final descriptions and accompanying figures were returned to the interviewee to be read over and checked for accuracy of detail.

It was found that as "two heads are better than one," so it is with interviewers. In this case two interviewers can aid each other considerably in keeping on the right track and in following detailed explanations. Covering prepared questions goes more quickly with interviewers taking turns asking a question while the other is finishing taking notes from the previous question.

Many good recommendations come from the operations staff themselves. The personnel involved are familiar with the problem areas. As the problem areas were discussed in the interview, recommendations were encouraged. Also the objective of the interview was brought home by the admitted existence of problem areas.

A good understanding of an activity was attained after completing the narrative with accompanying figures. To understand the system, however, the information gathered from various activities must be looked at from a higher level. The operation of any one activity is only a part of the system.

CHAPTER V

THE PRESENT SYSTEM

The Computer Facility at the U. S. Naval Postgraduate School has
as its primary mission to support the academic program, to serve as a
laboratory complementing courses in computer programming and logical
design, and to facilitate student and faculty research.

The computer system in operation at the Facility consists primarily
of a Control Data Corporation (CDC) 1604, an IBM 1401, and two CDC 160s.
Both CDC 160s are connected to the CDC 1604 in a satellite mode with
one located in another laboratory removed fifty yards from the main
area. This physical arrangement provides operational and research
experience in multi-processing systems such as those used in military
command and control situations. EAM equipment including card punches,
card sorter, flexowriters, etc., is also available. A complete list of
equipment is contained in Appendix B.

In addition to a Director, there are eight billets for mathematician/
programmers, and nine billets for operational support personnel including
four key punch/unit record equipment operators. As part of the mainte-
nance contract with the Control Data Corporation, two technicians are
in residence, working an eight-hour shift, Monday through Friday, and
on call at other times.

The current schedule of operations is as follows: 0800-2400 weekdays--
operated by the Computer Facility staff; 2400-0600--those students with

licenses to operate the computers may sign up for time to work on
special programs or projects; 0600-0800, and 0800-1200 Saturday mornings
is given over to maintenance; the remaining time on the weekends is allotted
to individual students.

It is estimated that approximately 70 percent of the computer time
is spent on student class assignments, 10 percent on theses projects,
10 percent on student and faculty research, and 10 percent on administrative
work.

Several programming languages and compilers are available at the
Facility. These include: ALGOL, CODAP, FORTRAN, SCRAP, and two list-
processing languages, IPL-V and SLIP. Additionally, a large number of
routines are available in the program library.

The remainder of this chapter will be devoted to a summary and
description of the administrative uses of the computers. As has been
stated previously, most of these programs came about, one-at-a-time, on an
"as needed" basis, and as time and staffing would permit. Figure 1, page
48, is the current Organization Chart of the U. S. Naval Postgraduate
School which shows the relationship of the various functions which do
use the computer facilities.

These offices are: Registrar, Naval Auxiliary Landing Field, Library,
Scheduler, Baccalaureate/General Line Curriculum, and Textbook Library.

Registrar

This office currently uses only the IBM 1401 system, and all key
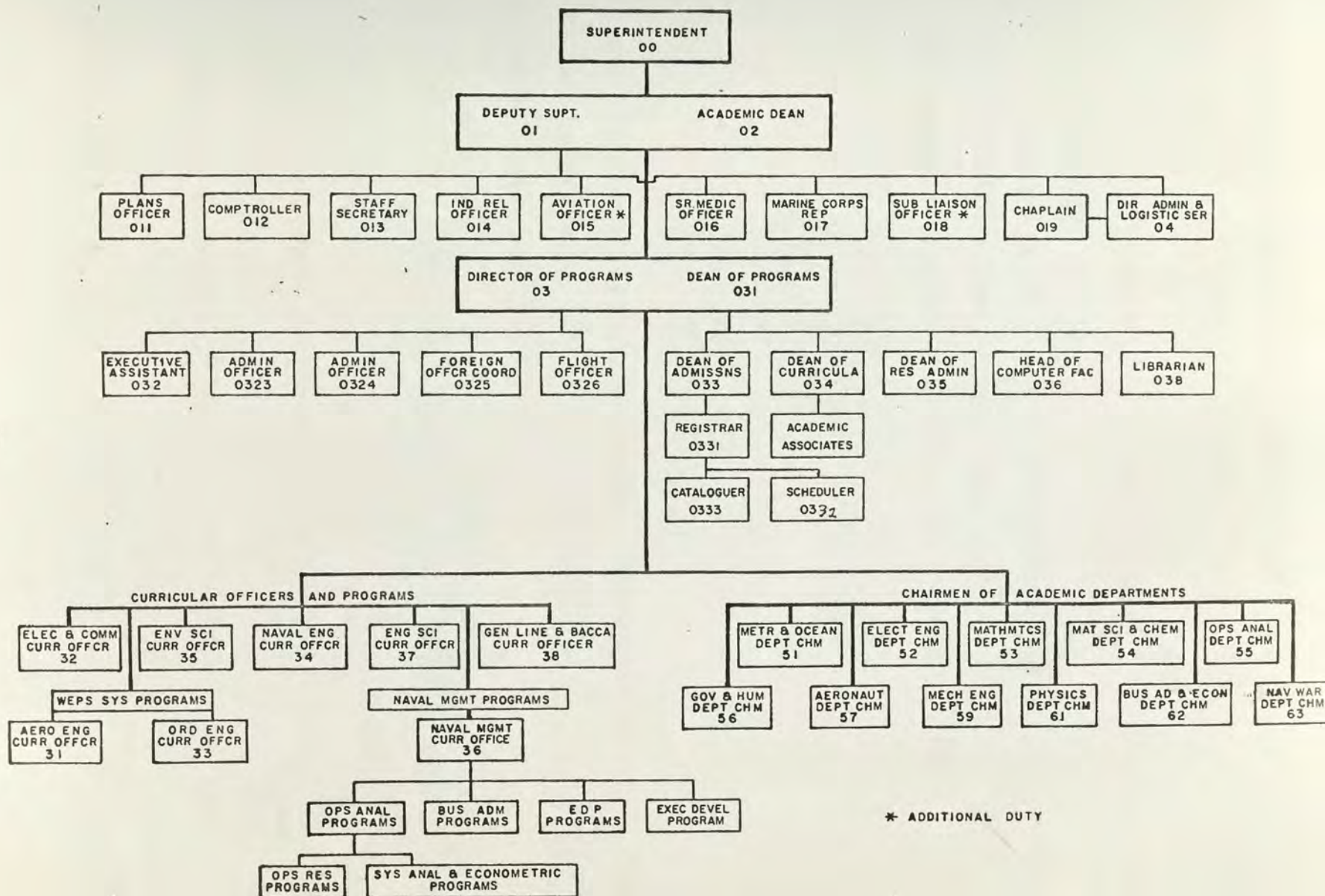punching is done by the Registrar's staff. Files are maintained on IBM

Figure 1.

Organization Chart, U. S. Naval Postgraduate School

cards, none on magnetic tape. Computer time averages a total of five
hours per term, though this is spread over various periods, and may vary.
While there is no set schedule, runs are made during the first three weeks
of the term, and during the ninth week generally. Card files are stored
in the Registrar's office.

As orders are received on incoming students, they are routed to the
Registrar's office where a Student Master Card (J card) is punched for
each student. Information included at this time is as follows:

```
Column:      1:  Card code  (J)
   "   :   4-5:  School code (Eng., Mgmt., etc.)
   "   :   6-9:  Group (Section within School)
   "   : 10-15:  File Number
   "   : 16-19:  Designator
   "   :    20:  Rank
   "   : 21-22:  Corps (Flyer or Non-flyer)
   "   : 23-25:  Sequential code
   "   : 26-48:  Student's name
   "   : 73-76:  Curriculum code number
```

After the officer has reported on board, additional information is taken
from a questionnaire filled out by him during registration, and punched
on the J card. This data includes:

```
Column: 49-52:  Date of Birth (Month and Year)
   "   : 53-56:  Date reported (Month, Day, Year)
   "   : 61-66:  Previous Academic school (NAVACAD, University, etc.)
   "   : 67-72:  Degree granted, if any
```

From this card, six course entrance cards are punched and given to the
student. One card is turned into the instructor for each course taken.
With the exception of columns 2 and 3 (year and term), the information
punched in the columns is identical to that punched on the J card.

A Header card is punched for each course scheduled during a term
from a list received from the Scheduler's office. Once a term has ended,

these cards are destroyed. Originally, an attempt was made to make

these cards permanent, but too many changes occurred, such as the course

title, name of the professor teaching it, number of hours recitation, etc.

It was deemed less time-consuming to punch new cards each term. Information

on the Header card is as follows:

```
Column:      1:  Card code
  "    :      2:  Year
  "    :   6-15:  Month and year term starts
  "    :  26-48:  Professor's name
  "    :  49-70:  Name of the Course
  "    :  71-76:  Course number
  "    :     77:  Segment number
  "    :  78-79:  Number recitation and lab hours
```

Course entrance cards are collected by the instructor and turned into the

appropriate Academic Department office where each class deck is arranged

alphabetically behind the Header card. (There is no program available

to do this on the computer.) These decks are then forwarded to the

Registrar.

During the first two weeks of each term, these decks are run through

the computer, and two copies of an "initial" class roster are produced.

The instructor notes any changes or corrections and returns copy two to

the Registrar. Class decks are corrected accordingly. In the third

week, information from columns 49-79 is gang punched into the individual

course cards, and the "permanent" class rosters are run. Column 80 is

left blank for later recording of the grade. Course cards, at this point,

are being filed and maintained by course. Changes are made as necessary,

but no new rosters are printed until the ninth week.

At this time, the official and final class roster is run for the

recording of grades. When grades are received, they are punched into
the course cards, a printout of the class roster with grades is obtained,
and returned to the instructor for verification.

Course cards are then sorted alphabetically by student on the IBM
1401. Each student's deck is then manually inter-filed with the previous
decks of prior terms which are maintained for every student. A student's
deck now contains a J card, a 4 card, and a course card for each course
taken while at the Postgraduate School. A 4 card is the **Balance** **Forward**
card and contains the following information:

Columns:		1-49:	Same as on the J card
"	:	49-51:	Number hours of recitation accumulated
"	.	52-54:	Number hours of laboratory accumulated
"	:	55-58:	Number graduate credit hours
"	:	63-66:	Number graduate quality points
"	:	67-70:	Total quality points
"	:	71-72:	Term
"	:	73-76:	Curriculum code

Transcripts are produced on the IBM 1401 which does all calculations
and prints out a cumulative transcript for each student. The deck is
maintained for each student during his enrollment at the school plus one
year following his detachment. For students in curricula which run longer
than one year, or which begin during the academic school year, the IBM
1401 will punch a new 4 card with the balance of credits and quality
points being carried forward at the beginning of each school year.

When running transcripts, the computer program has the capability
to detect cards out of proper sequence (for example, a term three course
card filed with the term four deck of course cards). The run stops, and
the reason for the error is printed out. A color stripe (different color

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for each term) is at the top of each course card--this insures that the student has not handed in a card from last term for a course being taken in the current term.

Additionally, a J card is maintained on every student attending any university under USNPGS cognizance. Not included, however, are those students attending civilian institutions under the five-term program, scholarship students, and Navy Enlisted Scientific Education Program students. Those officers in the Burke (Advanced Study) program are not administered by the School, but fees and book costs are paid for them by the School, hence a J card is maintained on these officers.

The J cards are used to provide the Official Register of officer students which includes which curriculum the officer is in and when he is expected to complete his studies. In addition to a multitude of uses for this register at the School, copies are sent to the Bureau of Naval Personnel for use by Detail Officers and others. As a service, the Registrar also provides a number of other listings which are distributed to the Library, Textbook Issue, Military Personnel Office, NALF, Curricular officers, Disbursing, Student Mail Center, Security Office, Medical/Dental, Special Services, Housing, etc.

Information from the J cards is also pulled manually for inclusion in the Monthly Training Report submitted to the Bureau of Naval Personnel. Also, all data required for preparation of the budget concerning the cost of fees and books for students at civilian schools must be determined using the J cards as a basic source of information. At present, there is no way

to do this via the computer. A brief flow chart of the Registrar's system is in Figure 2, page 54.

Naval Auxiliary Landing Field (NALF)

NALF presently uses the IBM 1401 computer system with three different computer programs: a weekly Flight Schedule, a monthly Station Master Log printout, and updating and printing of the Pilot's Log. Additionally, a Flight Pay List is run monthly, not using the computer. Since both Naval Aviator and Naval Aviation Observer (NAO) records are processed by NALF and the computer programs, both groups will be referred to as pilots. Enlisted personnel attached to the NALF Training Department key punch all input data cards for the various programs utilizing equipment on loan from the Fleet Numerical Weather Facility. All files, card and tape, are maintained at NALF.

Input data to the computer programs and Flight Pay List is taken from two basic documents. The Aviation Training Data form (Figure 3, page 55) supplies all the information required for the Flight Schedule card, the Pilot Log Header card, the Flight Pay card, and some of the data for the Pilot's Log card. The Naval Aircraft Flight Record, or "yellow sheet" (Figure 4, page 56) is filled in by the pilot immediately following each flight. Information from this form is added to the Pilot Log card, and is also used for the Station Master Log. Specific data taken from each source document and punched onto the input cards is charted in Figure 5, page 57.
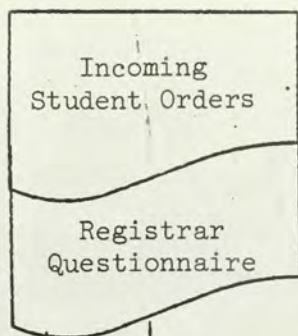
When an aviator reports aboard and completes the Aviation Training
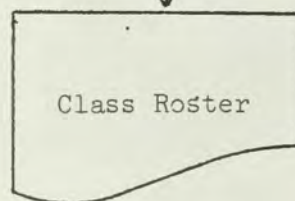
53

Figure 2a.
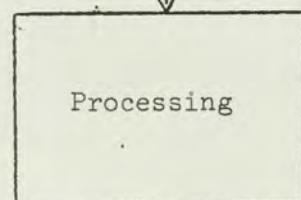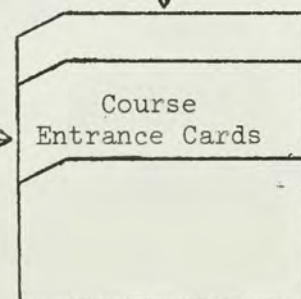Preparation of
Class Roster

Figure 2b.
Recording of Grades
and Preparation of
Transcript
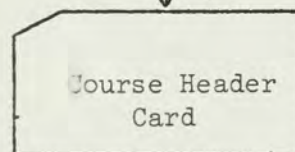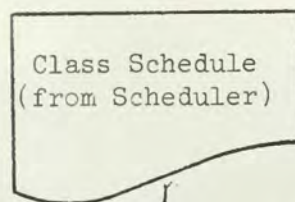
Figure 2.
Flow Diagram - Registrar

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12ND NAF 3740/4   AVIATION TRAINING DATA
(Rev 12/64)

Name_____Rank_____SERVICE_____FILE NO_____
        (Last)   (first)   (Middle)

Current Duty Station_____Date Reported_____

SMC# Box No. _____   Estimated Detach Date_____

Local_____ Home Phone _____
                                                (Notify if change occurs)
Address_____
****
Type Instrument Card_____   Fiscal Year Total (Since 1 July):

Expiration Date_____   Total Pilot   _____.____

Date Last Press. Chamber/Ejection   First Pilot   _____.____
Seat Training _____
                                            Co-Pilot   _____.____
Type Aircraft Flown and Year Last
Squadron Tour_____   Acft Cdr   _____.____

Total Jet Time _____   Special Crew   _____.____

Total Accum. Time as of 30 Jun Last: Actual Inst.   _____.____

   Pilot   _____.____   Simulated In st   _____.____

   Aircraft Commander _____.____   Total Night   _____.____
****
I certify that I am current in the below listed type(s) aircraft, having 10 hours
of first pilot time in the last 6 months. Indicate date(s) of last NATOPS stan-
dardization in these types.

UC-45J_____ T-28B_____ T-2A _____ CH-19E _____ S-2/C-1 _____

                            Signature_____

Figure 3.

Aviation Training Data Form

NAVAL AIRCRAFT FLIGHT RECORD

OPNAV FORM 3760-2 (REV. 5-61)   "YELLOW SHEET"   DATE.

A/C MODEL	BU. NO.	A/C SIDE NO.	A/C REPORTING CUSTODIAN	FLIGHT CODE

C —A/C, ENGINE, AND ACCESSORY RECORD OF OPERATING TIME— Record Hours and Tenths

OPERATING TIME IN HOURS & TENTHS	ENGINE(S)				ENTER ACCESSORY TIME; APU, ROTOR, GEAR BOX, ETC. FOR LOG PURPOSES				
	1	2	3	4					
PRIOR TO THIS FLIGHT									
THIS FLIGHT									
TOTAL									
COMBAT POWER/ AFTERBURNER									

LANDING SUMMARY BY TYPE	CARRIER			WATER	FCLP	FIELD	
	ARREST.	T & G	BOLTER				

A/C INSPECTION RECORD	TYPE INSPECTION		LOGS POSTED BY	
			A/C	ENG.
A/C TIME SINCE INSPECTION				
A/C TIME THIS FLIGHT				
TOTAL				

USE REVERSE OF THIS PART FOR AMPLIFYING REMARKS CONCERNING A/C PERFORMANCE, TEST FLIGHTS, ENGINE RUN-IN, ETC.

D —OPERATIONS   Record All Time in Hours and Tenths of an Hour

	FLIGHT	TIME (Local)	ZONE	DATE	PLACE
	DEPARTED				
S T O P S	ARRIVED				
	DEPARTED				
	ARRIVED				
	DEPARTED				
	ARRIVED				

FLYING TIME CREDIT FOR PILOT(S) AND STUDENT PILOT(S) (List non-pilots on reverse)	A/C CDR. TIME (AC)	PILOT TIME			SPEC. CREW TIME (SC)	INSTRU-MENT TIME 2.	NIGHT TIME	LANDINGS BY TYPE						INSTR. APPROACH, COMPLETE		NO. OF JATO OR CAT. T.O'S.
		TOTAL	1ST PILOT (FP)	CO-PILOT (CP)				CARRIER			WATER	FCLP	FIELD	NO. 2.	TYPE 4.	
								ARR. 3.	T &G 3.	BOLT 3.	3.	3.	3.			
PILOT IN COMMAND																
1.																
1.																
1.																
1.																
TOTAL																

FOOTNOTES:

1. Include name of unit and/or Flight Code if different than data entered for Aircraft.
2. Enter "S" if Simulated.
3. Enter "N" if Night.
4. Enter * code to indicate type of final approach.

A—AUTOMATIC	G—GCA	O—OMNI	* J—Prefix to other
C—CCA	I—ILS	R—RADAR	codes if JET
F—ADF	L—LF RANGE	T—TACAN	PENETRATION.

A/C REPORTING CUSTODIAN	
A/C MODEL	BU. NO.
A/C SIDE NO.	FLIGHT CODE

LOGS POSTED		
MASTER	PILOT(S)	OPNAV B & C

I Certify Parts C and D to be Complete and Correct.   PILOT'S SIGNATURE

Figure 4   Naval aircraft Flight Record

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Source Document   Program Input Cards

AVIATION TRAINING	DATA FORM	YELLOW SHEET		PILOTS LOG	HEADER CARD	FLIGHT SCHEDULE	PILOTS LOG	PAY LIST	STATION MASTER LOG
X	X		NAME	X	X	X	X	X	
X	X		RANK	X	X	X	X		
X	X		SERIAL NUMBER	X			X		
X			SERVICE	X	X				
		X	AIRCRAFT TYPE		X	X			
X			AIRCRAFT QUALIFICATION		X			X	
X			INSTRUMENT QUALIFICATION		X				
X			INSTRUMENT CARD EXPIRE DATE		X				
			INSTRUMENT BOARD MEMBER		X				
			MEDICAL GROUP		X				
			MEDICAL CATEGORY		X				
X			HOME PHONE NUMBER		X				
X			PRESSURE CHAMBER EXPIRE DATE		X				
X			OTHER AIRCRAFT QUALIFICATION		X				
X			CURRENT IN OTHER AIRCRAFT		X				
X			NATOPS STANDARDIZATION CHECK		X				
	X		DATE (TODAYS)		X	X		X	
	X		AIRCRAFT BUREAU NUMBER			X		X	
	X		FLIGHT PURPOSE CODE			X		X	
X			LIFETIME FLIGHT HOURS	X					
	X		TOTAL FLIGHT TIME (THIS FLIGHT)			X			
X	X		FIRST PILOT TIME			X			
X	X		COPILOT TIME			X			
X	X		AIRCRAFT COMMANDER TIME	X		X			
X	X		SPECIAL CREW TIME			X			
X	X		ACTUAL INSTRUMENT TIME			X			
X	X		SIMULATED INSTRUMENT TIME			X			
X	X		NIGHT TIME			X			
	X		NUMBER AND TYPE INSTRUMENT APPROACHES			X			
	X		DAY LANDINGS			X			
	X		NIGHT LANDINGS			X			
X			STUDENT MAIL CENTER NUMBER	X					
X			TAKE OFF/LAND AND TIME/PLACE					X	
X			CREW MEMBER	X					

Figure 5.

Information for the NALF Programs -
Original Source Documents and Program Input Cards

Data form, one of each type of input card is punched except that ten Pilot Log cards are gang punched and filed behind the Pilot Log Header card.

The longest of the three programs is the Pilot's Log program. Approximately fifteen minutes are required to read in the input data cards, one hour for a sort/merge run utilizing the IBM 1401 system with the 1311 Disk Packs, and one hour is needed on the high-speed printer for the output. Since all pilots are separated into two wings, one wing flying each week, the program must be run twice a month.

When a "yellow sheet" is received by the NALF Training Department signifying that a flight has been completed, a Pilot's Log card is pulled for that pilot, and the card punched with the necessary information. (See Figure 5, page 57.) All the Header cards and individual Pilot Log cards for a wing are read into the computer and stored on magnetic tape. During the sort/merge routine, the data is arranged chronologically and matched to the Header card by name. Should the routine not find a match, data for that pilot is printed out for an error check, no updating of totals occurs, and the program continues. When a match does occur, a record is formed consisting of the Header card data and the data from all the Pilot Log cards for that pilot. Lifetime flight-hour totals are updated, and the entire record is printed out, one pilot's record per page. The Pilot Log Header card is used to establish the record on magnetic tape. The printed copy is returned to the pilot via the Flight Office at the Postgraduate School. It provides the pilot with a record of his flight time, and also serves as a constant check on the accuracy of the output.

The match by name rather than by file number is done to detect key punching errors. If one digit of the serial number is mispunched, the wrong record could be updated; the data will be rejected if a name is encountered with a mispunched character. Since the personnel doing the key punching are not trained operators, it was considered necessary to design the program in this manner. Figure 6a, page 60, outlines the procedures used in this program.

The Flight Schedule cards are filed by time of flying (e.g., Monday morning, Monday afternoon, etc.), and within this time period by aircraft type. Prior to the running of the weekly Flight Schedule, the file is gone through manually and those pilots not flying that week are removed from the file. The cards are read into the IBM 1401 system and the Flight Schedule output is written on magnetic tape. The printout is obtained by running the tape, rewinding it, each time to provide eight copies of the Schedule. Three copies are posted: in Root Hall, Flight Office, and at NALF. The other five copies are filed. Figure 6b, page 60, contains a flow chart of this program.

The Station Master Log program is run at the end of the month. The Log's purpose is to provide a record of daily aircraft usage. As shown in Figure 5, page 57, data is taken from the "yellow sheet" and punched onto a Station Master Log card. These cards are then sorted chronologically on the IBM 82 sorter, and then read into the IBM 1401. The printout shows, by date, the type of aircraft flown, the total flight time for each flight, the purpose of the flight, the names of all those aboard the aircraft during the flight, etc. (The reason a separate Station Master Log card must be cut in addition to the Pilot Log card
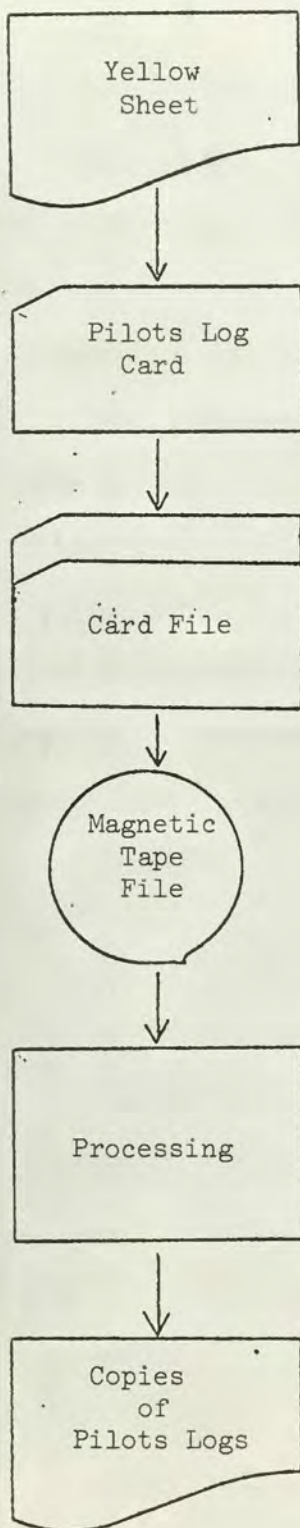
59

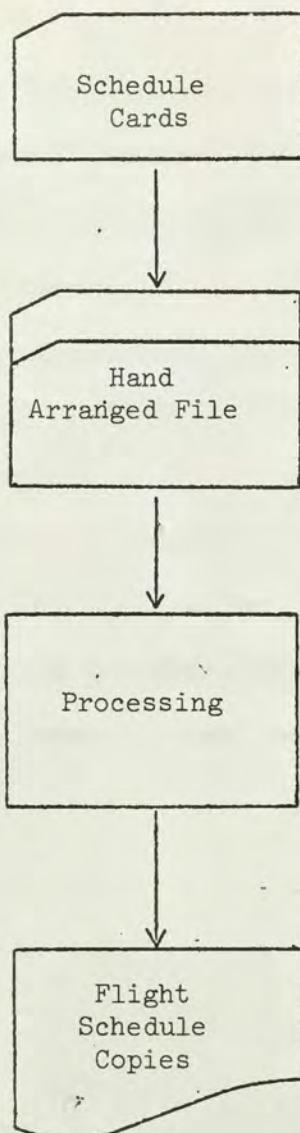Figure 6a.

Pilots Log Program

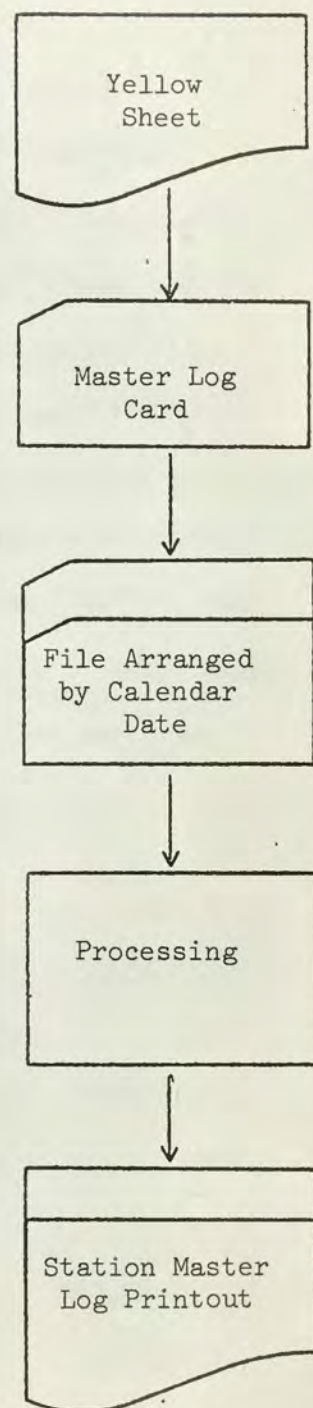Figure 6b.

Flight Schedule

Figure 6c.

Station Master
Log Program

Figure 6. Flow Diagram - NALF

is that there is insufficient column space on the latter card to include the names of all aboard the flight.) The program takes approximately two hours to run, and is briefly flowcharted in Figure 6c, page 60.

Disbursing requires a monthly list of the pilots who have qualified for flight pay. NALF manually pulls the Flight Pay cards of those who have not acquired sufficient time during the previous month, and runs the remainder of the file through an accounting machine to print the list.

There are about 800 pilots stationed at the Postgraduate School whose records are processed by NALF, and more than four cards are maintained for each pilot. A minimum of two flights per month are flown by each pilot, making a total of at least 1600 "yellow sheets" to be tabulated at least twice per month for two different program inputs. The number of personnel required to maintain these records has been reduced by three with the introduction of the computer.

Library

The U. S. Naval Postgraduate School Library uses both the CDC 1604 and the IBM 1401 computer systems for two primary programs. The first of these programs is concerned with compilation of serial listings of periodicals (magazines, journals, etc.) by title, arranged alphabetically and also by subject. Information on a particular periodical is maintained on an IBM card; when a new publication is received, a card is punched and retained with the permanent file. Key punching is done by the Computer Facility staff.

The permanent file is updated by the IBM 1401 annually, and a new listing is run. Printing is done on multilith masters which are then

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reproduced to provide the necessary number of copies. The IBM card file is maintained by the Processing Department of the Library.

The other program is utilized by the Library's Technical Reports Section and is called SABIR 2-Semi-Automatic Bibliographic Information Retrieval System-Stage 2. The system supplies a bibliographic output that answers accurately questions submitted concerning documents available on a particular subject. Bibliographies will include corporate authors (sources), titles, personal authors, dates of publication, report numbers, and number of pages per report. It is also possible to ask for a search on the basis of source, or the date(s) of issue of technical reports rather than by subject.
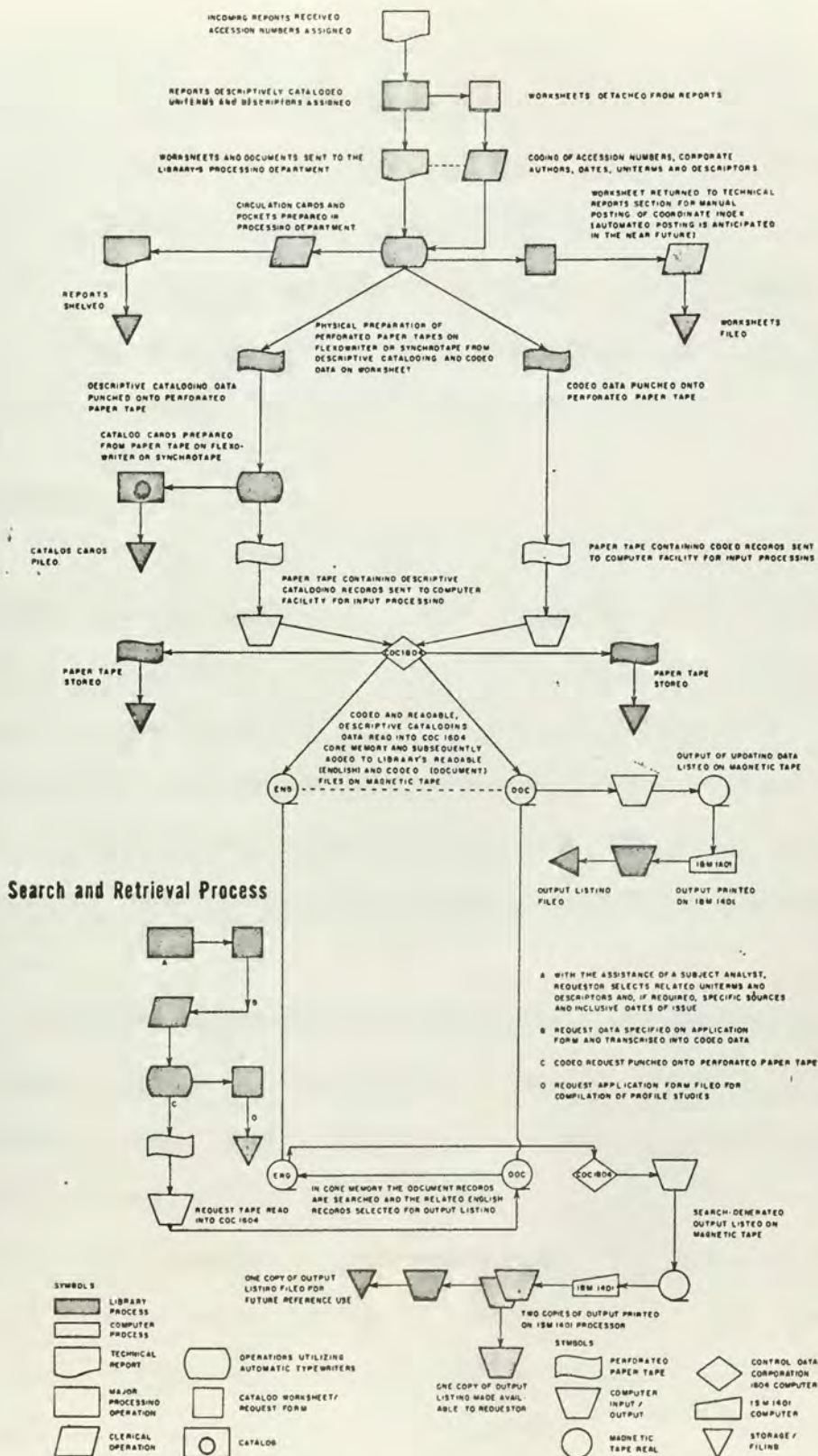
Approximately 25,000 records are stored on magnetic tape, both classified and unclassified. Only those documents that have been received since November, 1960 are included in the system at present.

Updating should be done on a weekly basis, however, with the current limitations of time and personnel, it is done once a month. Some 250 documents are added during an update run. The update tape is a paper tape prepared by Flexowriter, and punched by library staff personnel. Requests for literature searches are coded, punched on paper tape, and are submitted twice daily to the Computer Facility for processing. A complete outline of procedures used for maintaining and updating the master file, as well as for literature searches is shown in Figure 7, page 63.

The average time required for processing a search from the initial request until the bibliographic output is ready for pickup is two days.

Figure 7. Flow Diagram - SABIR - 2

During the peak periods, however, in terms of both computer time and number of requests, it may take as long as a week to get a printout. Neither of these situations is considered desirable. The purpose of the system is rapid retrieval of information for the user. It is hoped that eventually this time lag will be shortened. Actual update time of the master file is approximately forty-five minutes per run; search runs, including printing, take about twenty-five minutes.

Scheduler

This office currently uses both the CDC 1604 and IBM 1401 computer systems. All key punching is done by Computer Facility personnel; input files are maintained on IBM cards and stored at the Computer Facility. Results of the computer runs are stored in the Scheduler's office. Total time per term is estimated at three hours on the IBM 1401 system, and one hour on the CDC 1604 system; however, this time is taken up usually by short runs done periodically throughout the term and may vary from run to run.

Two of the main functions performed by the Scheduler are aided by computer programs, Forecasting and Scheduling. The forecast cycle begins with the receipt of the estimate of the number of students for the coming year from the Bureau of Naval Personnel. This information is recorded on a form "Input Data for ____Forecast of FY___ Teaching Requirements," along with the on-board count of students. This data is broken down by term for a full school year for each of the fourteen curricula, and the forms are forwarded to the Curricular Officers and Academic Chairmen. At this point, a time schedule is established for completing the Departmental Teaching Load Forecasts. These forecasts are normally required

twice a year, however, it is not uncommon for them to be requested more often, always on a crash basis.

The curricular offices submit the following information for the Five Term Academic year: Curriculum, Term, Group, Number of students in each group, and the specific courses each group is currently scheduled to take. This data is submitted to the Computer Facility where cards are punched, and printout of the data is obtained. (Figure 8, page 66) Also run at this time is a Departmental Loading Forecast, (Figure 9, page 67), which is returned to the departmental offices for verification and preparation of the Teaching Workload Forecast. (Figure 10, page 68)

Several reports are generated from these Teaching Workload Forecasts, all manually:

1. Forecast of Number of Faculty Members Required for Teaching Only During (specific year).
   (Based on 11 Contact Hours per Faculty Member and an Average Officer Student Enrollment of _____).

2. Average Number of Faculty Members per Term Required for all Duties During (specific year).

3. FY___ Student Contact-Hours per Faculty Member

4. (Yearly) Faculty for Teaching Only and the Officer Student Enrollment
   (____Forecast, Actual Requirement and Capacity Provided)

The Departmental Teaching Load forecasts, in various forms, are used for budget requirements, recruiting faculty, military construction programs, and planning student programs for future academic years. The time period involved to work up a forecast is four weeks from source data to completed work sheets.

The scheduling cycle occurs every term, and it takes nearly the whole term to produce the complete schedule. Data submitted for the Five Term

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TERM SECTION	# STUDENTS	COURSES SCHEDULED
3 MMZ3	/19	MR218 MR422 OC615
3 MEZ3	/19	OC212 OC213 OC615
3 MAZ3	/17	MR218 OC202 OC604
3 MMZ4	/15	MA261 MA332 MR202 MR212 MR321 OC230
3 MEZ4	/15	MA261 MA332 MR202 MR212 MR321 OC230

Figure 8.

Sample of Printout Generated by Data Submitted

for Five Term Loading Forecast

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Term	Course	Hrs. rec./ lab	Sec.	Number of Students
1	AE-104	3 2	AAZ4	20
			ABY4	20
			ACY4	20
				60
3			AAA5	20
			ABB5	20
				40
2	AE-105	3 2	AAZ4	20
			ABY4	20
			ACY4	20
				60

Figure 9.

Sample Departmental Loading Forecast

Teaching Workload Forecast

Department _____

		TERM I			TERM II			TERM III			TERM IV			TERM V		
Course No.	Contact Hours	No. Stu	No. Sec	Fac. Hrs	No. Stu	No. Sec	Fac. Hrs	No. Stu	No. Sec	Fac. Hrs	No. Stu	No. Sec	Fac. Hrs	No. Stu	No. Sec	Fac. Hrs

Figure 10.

Sample Heading for Teaching Workload Forecast

Academic Year is also used in the scheduling process. A copy of the printout, as shown in Figure 9, page 67, is returned to the curricular offices for the coming term for verification and correction. The corrected version is then sent back to the Scheduler, with additional changes dated and submitted as they occur. The revised version is then forwarded to the Computer Facility for updating and re-run. Also printed out at this time is a Term Loading Schedule by department. This listing shows by term, all courses to be offered during a particular term, the hours of recitation and laboratory, the specific sections scheduled to take a course and the number of students per section. Three copies are sent to the departmental offices where the following information is added: number of segments of each course to be taught, the name of the professor assigned to each segment, and what texts are to be used with each course. One copy is retained by the Department Head, one copy is sent to Textbook Issue, and one copy is returned to the Scheduler who then manually builds the term's schedule.

The time period required for this complete cycle includes three weeks from source data to completed work sheets, four weeks for actual schedule construction, and one week for review, typing, reproduction and distribution. The schedule must be published at least one week prior to the start of the new term.

Additionally, the Scheduler provides a list of all courses to be offered, including course number, name of professor teaching the course, number of hours, etc., to the Registrar so that she may prepare Course Header cards. A flow chart of the Scheduler's two programs will be found in Figure 11, page 70.
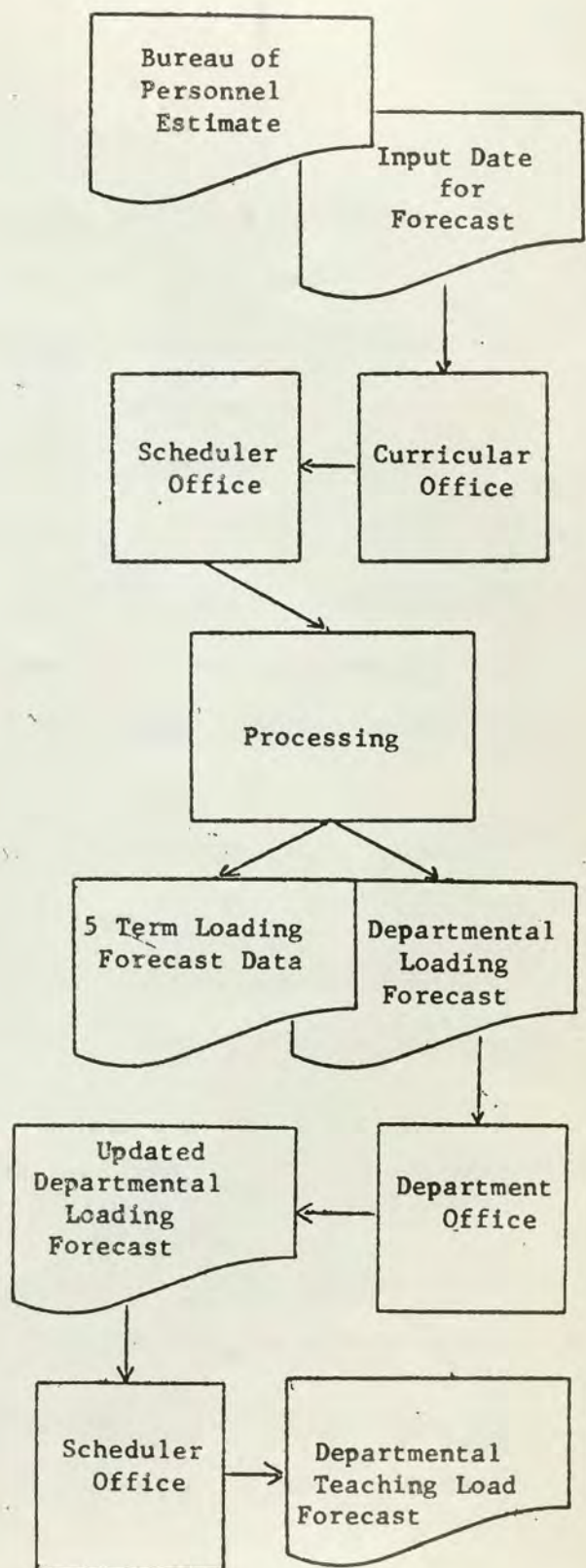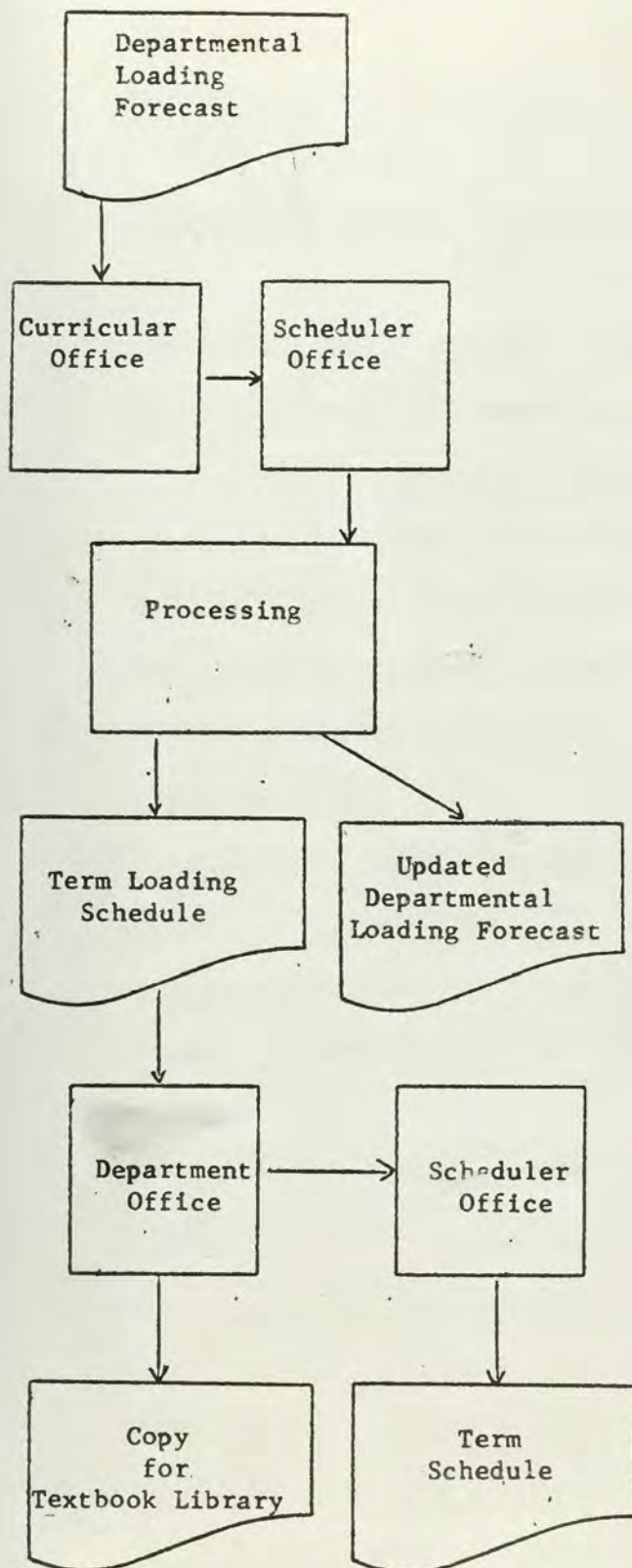
Figure 11. Flow Diagram - Scheduler

General Line and Baccalaureate Curriculum

This curriculum contains the largest number of officer students, both U.S. and foreign, in the School, and is most like a regular university program. However, the students have widely varied backgrounds and commence their studies at the Postgraduate School at different levels. This office uses the computer to aid their scheduling process.

After each student has conferred with his academic advisor, he completes a form (one covers each section) with the numbers of the courses he is to take in a prescribed order. These listings are forwarded to the Computer Facility where IBM cards are punched for each student with the following information: student name, flying status, courses to be taken, sub-group letter, term, and section code.

From these cards, two programs are run on the IBM 1401 computer. The first program BACC3, is a simple list program which prints out by section, the names of those in the section, flying status, and course numbers by term. This output is held by the General Line/Baccalaureate office.

The second program, SKED4, is similar to that run for the Scheduler's office. It, too, is run on the IBM 1401. The output is a listing by term and section of the number of students (and flyers) in the section, and the specific courses each section is taking. IBM cards are also punched at this time with the same information. These cards plus a copy of the listing are forwarded to the Scheduler's office to assist her in the over-all scheduling cycle.

Both programs are normally run once each term. Estimated total time for card punching and computer runs is two hours per term, though

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this is spread out over several weeks.

Textbook Library

The Textbook Library uses both the CDC 1604 and IBM 1401 computer systems to aid in maintaining textbook inventory. The master file consists of one IBM card identifying each of the approximately 1500 students enrolled in the Postgraduate School, plus one IBM card for each book drawn by the student. Books drawn by the staff are included in a separate file which is maintained manually although the cards themselves are in the same format as those in the master file. Over 20,000 cards make up the master file, and all key punching is done by Textbook Library personnel.

Information for the Student Identification card is taken from a section of the Library Information card, completed by the student when he is issued his library card. (Figure 12, page 73) The following data is punched on the IBM card: name and rank, curriculum, library card number, and student mail center number.

Upon receipt of a shipment of books, a five-digit Textbook Stock Number is assigned to each group of texts, (i.e., identical title and author) for identification. Editions are indicated by a dash after the stock number and the edition number. IBM cards are gang punched with this number and one card is filed in each copy of the text before it is placed on the shelf for issue. Additionally, three other types of cards are punched and used for catalog listings. The three listings provided are by author, by title, and by numerical order (i.e., Textbook Stock Number.)

Name & Rank _____

                 Last   First   Initial

Group or Department _____ SMC No. _____

Local Address _____

                        _____

                      _____
                            Signature

Name & Rank _____

                 Last   First   Initial

Group or Department _____ SMC No. _____

Local Address _____

                        _____

Name & Rank _____

                 Last   First   Initial

Group or Department _____ SMC No. _____

Forwarding Address _____

_____

CHECKED OUT

Reference Library _____   Card No. _____

Text Library _____

Buckley Library _____   Picked Up _____

Classified Library _____
12ND 6873

Figure 12. Library Information Card

To draw a book from the Textbook Library, the student requests the text by its stock number. The IBM card is removed from the book, initialed by the student, and his library card number is written on the card. Later, the library card number is punched on the textbook card and it is filed manually behind the appropriate Student Identification (Header) card. It should be noted that the Master File is maintained by Library Number card sequence.

At approximately mid-term, the Master File becomes the input for the computer program. The output is a printed list of the books held by each student, one student listing per page, which is forwarded to the student via the Student Mail Center. (See Figure 13, page 75.) The listing serves two purposes; first, it gives the student a record of the books in his possession, and secondly, it serves as a check on the accuracy of the Textbook Library's card files. Should any discrepancies exist, for example, a text posted to a listing which is not held by the student, or which had been turned in previously, they can be resolved immediately. A flow chart of this process is shown in Figure 14a and 14b, page 76.

As stated previously, one copy of the Term Loading Schedule is received from the Curricular offices with the texts that are needed for the coming term, and the number of each required. Each term, certain textbooks must be recalled as the number in stock will not fill the requirements of the coming term. Students are encouraged to retain all the texts that they have drawn as long as they require them until the texts are recalled. This policy allows the Textbook Library to

1234 (Student Mail Center)   12345 (Library No.)

STUDENT'S NAME

    THE RECORDS OF THE TEXTBOOK SERVICE BRANCH INDICATE THE
FOLLOWING TEXTBOOKS IN YOUR POSSESSION. NOTIFY THE TEXTBOOK
SERVICE BRANCH OF ANY DISCREPANCIES IMMEDIATELY.

STOCK NO.	AUTHOR	TITLE
* 136	LUCE	GAMES AND DECISIONS 1ST ED 1957
143	KEMENY J	FINITE MATHEMATICAL STRUCTURES 1
* 180	DRESHER M	GAMES OF STRATEGY 1ST ED 1961
433 1	MCCLOSKEY	OPERATIONS RESEARCH FOR MANAGEMENT
433 2	MCCLOSKEY	OPERATIONS RESEARCH FOR MANAGEMENT
436	MCKINSEY J C	THEORY OF GAMES INTRODUCTION TO
* 474	GRABBE	AUTOMATION COMPUTATION AND COTR
944	WILLIAMS J D	COMPLETE STRATEGYST 1ST ED 1954

* MUST BE RETURNED TO TEXTBOOK SERVICE BRANCH PRIOR TO DRAWING
  TEXTBOOKS FOR NEXT TERM.

Figure 13.

Sample Printout of Books Charged to a Student

| Textbook Stock Number | | Requirements from Department Office | | Shelf Count |

Punch Library Card Number

List of Books that must Recalled

Master File

Master File

Processing

Processing

Student Copy of Books Held

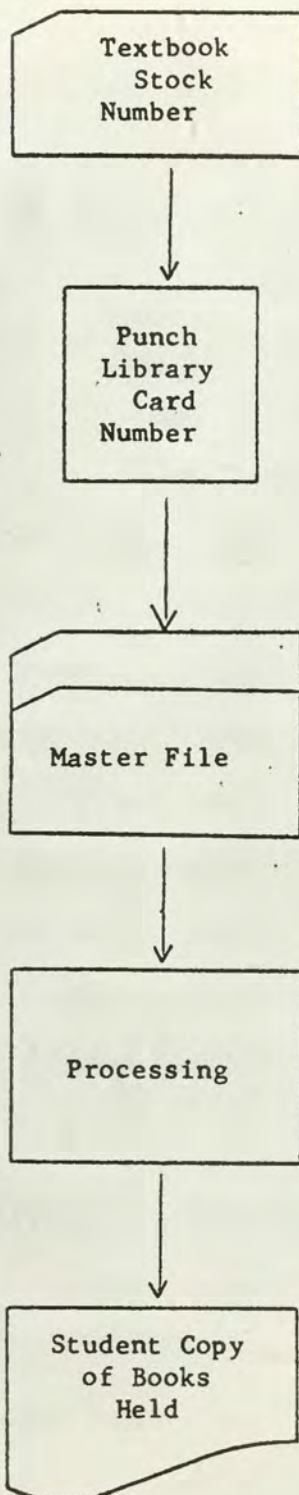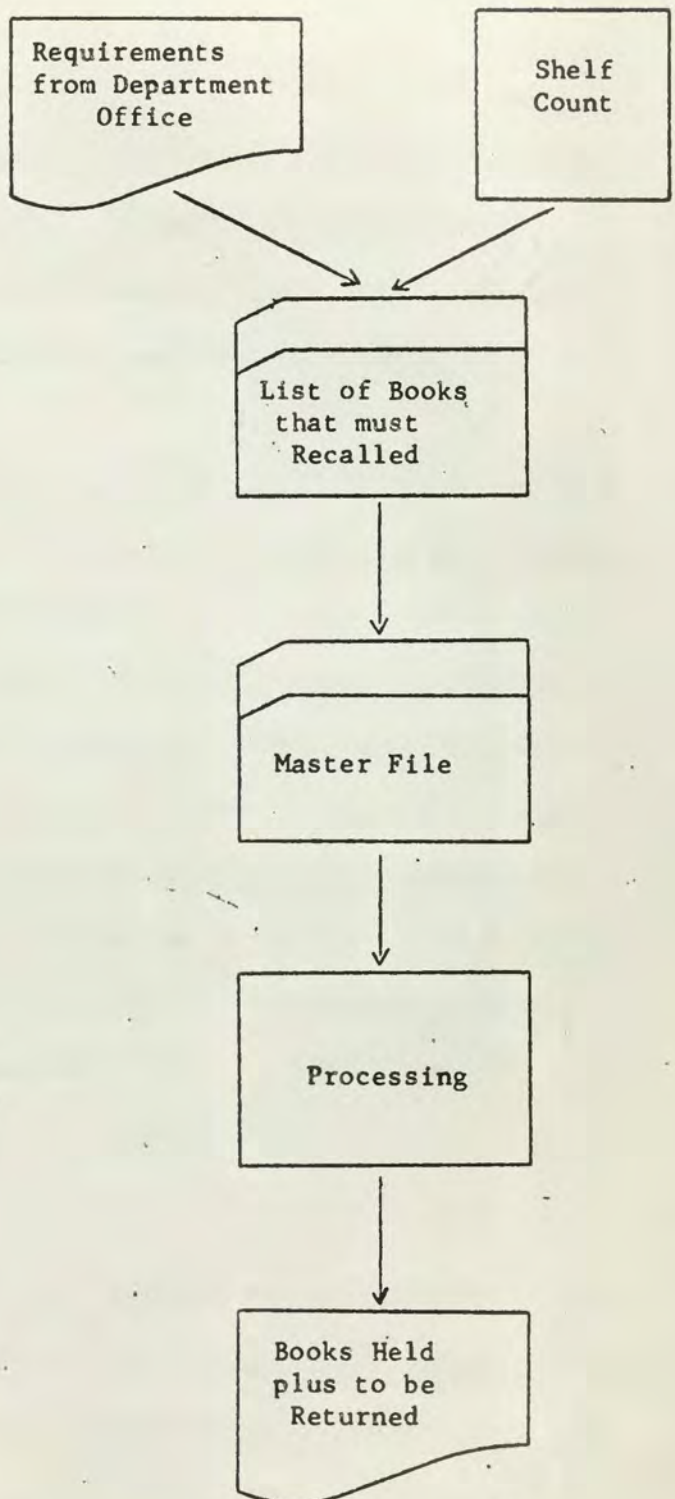Books Held plus to be Returned

Figure 14a.

Mid-Term Run

Figure 14b.

End of Term Run

Figure 14.   Flow Diagram - Textbook Library

maintain an inventory of textbooks larger than available shelf space.

Those books to be recalled are determined by schedule requirements, and the number on the shelves. Cards are punched with this information to form an additional input to the Textbook Library's second computer program, which matches the books held by each student with the list of books that must be recalled.

This run is made near the end of a term, and the printout, similar to the first run, indicates which books must be returned by the student prior to his drawing of the next term's texts. If a text held by a student is needed by him for a course in the coming term, he need not turn it in. This recall of texts usually assures that there will be sufficient copies available for issue as required. Two copies of the output are printed; one copy is retained by the Textbook Library for use in checking-in returned books, and the other copy is for the student.

Each run of the computer program requires both computer systems, and takes approximately two and one-half hours. An additional hour and a half is needed on the printer for each printout.

Research Project-Coursewriter

Another demand made on the current computer system during the past five months has been in relation to the IBM Coursewriter system as follows: approximately ten hours per week with research project personnel at the IBM 1050 typewriter terminal, and approximately three hours per week for programming system development by IBM personnel.

Should the project be developed to the point where regular students are taking courses at the terminal, hourly usage may go to forty hours

or more per week.

The system is programmed to time-share the IBM 1401 with the normal off-line card/tape and tape/print operations. In practice, thus far, only about two hours of the above ten hours per week have been time-shared. The Coursewriter compiler uses the IBM 1401, 1311 disks, 1409 and 1026 interface black boxes, and the 1050, 1051, 1052 input-output typewriter system. Further research is continuing. (Although this project is not an administrative function, it has been included because of its major significance and use of the computer.)

Miscellaneous administrative requests are received by the Computer Facility from time to time for special listings or for faculty and student statistics. The data is sent to the Facility, cards are cut, and the listings produced.

This chapter has attempted to give as clear and concise a picture as possible of the present administrative use of the computer systems. While only a relatively small percentage of the total available computer time is used for administrative functions, it is readily apparent that good use has been made of that time. Further development is warranted and is discussed in Chapter VI.

CHAPTER VI

PROBLEM AREAS AND THE FUTURE SYSTEM

As a survey of literature concerning educational data processing systems reveals, most of the applications occur in large school districts, and in universities and colleges. Any transfer of their experiences, however, must be tempered by recognizing the differences between these institutions and the U. S. Naval Postgraduate School, and by examining the problem areas involved. Although the School is a well-established educational institution, it is also a military organization, and this fact must be clearly recognized.

I. DIFFERENCES

Differences between the USNPGS and other Universities and Colleges.

There is no admissions function, per se. Officers indicate on regularly submitted duty preference cards their desires for postgraduate schooling, or in certain cases, they submit letters requesting a specific course of instruction. A selection board meets in Washington, with representatives of the School faculty sitting as advisors, to select those officers for advanced education, or to acquire their bachelor's degree. The main criteria are past performance in duty assignments, vice outstanding academic background, and availability. Evaluation of previous academic work is done by the selection board prior to selection, and any evaluation by School personnel is done after the student has been selected.

Thus, there is no application procedure, and no letters of acceptance
or rejection by the School. Those officers selected are ordered to the
School for a specific curriculum. Quotas are set by the Bureau of Naval
Personnel, based on the needs of the service, and the School's facilities.

The academic background of the officers is infinitely more varied
in relation to the fields for which they are chosen than the average
postgraduate student at a civilian university. In many instances, the
officers will work on advanced degrees in a field not related to their
undergraduate pursuits. Additionally, most of them have been away from
the classroom and the academic routine for three to twenty years. They
are sent for a specified period of time, and if they are unable to complete
the program in the time allotted, they usually do not have the option of
remaining an additional term or terms to complete degree requirements.
For this reason, coursework is fairly rigidly controlled.

While various forms of recreation are available to the student,
there are not the numerous extracurricular activities associated with
civilian schools such as the student council, student newspaper, yearbook,
intramural sports, etc. There is no requirement for coordination with
these activities, nor is there any paperwork involved.

There is no requirement for accurate attendance accounting, as in
other institutions. This does not mean to imply that officer students
are not expected to attend classes, but accurate records need not be
maintained. In many state-supported schools, the attendance records are
needed for justification of state funds, and for all Veteran's Administration
programs, accurate records must be kept.

Fee payment problems such as tuition, laboratory fees, student
activities fees, etc., do not exist, and therefore, a requirement of
this capability need not be included in system requirements for the
School. Also, there are no problems with scholarship grants or student
loans. Military pay is processed as it is at other military installations.

Most universities and colleges require students to purchase their
own texts, and a minimum of coordination is needed between academic
departments and the student bookstore. At the Postgraduate School,
however, the students are issued all required texts for their courses.
As indicated in Chapter V, a much closer coordination is required between
the curricular offices and the Textbook Library.

Most student data processing systems developed at various civilian
schools include many of the functions just noted. Therefore, differences
covered thus far, in addition to any others to be discussed, must be
recognized prior to the adaptation of any of these systems to the needs
of the Postgraduate School.

Key Differences Causing Unique Problems.

Scheduler. A major problem area is that of scheduling classes, and
the main difference between procedures at the USNPGS and other educational
institutions is that at other schools, the master schedule of courses to
be offered during a particular term is made up in advance, and the students
build their own schedules from the master one as they wish. Any conflicts
arising during this process are resolved by the student himself, or in
consultation with his advisor as necessary. At the USNPGS, the procedure
is reversed. Curricular offices submit a list of courses to be taken by

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each section, and the Scheduler then builds the master schedule.

But, this process is not as simple as it sounds. There are numerous constraints and difficulties encountered in scheduling all required courses in this manner.

There is a policy that once a section of approximately 20 students has been established within a curriculum, it is to be maintained as a unit, insofar as possible. Even though several sections may be programmed for the same course, which would allow for cross-sectioning of students, courses are scheduled by section. In other words, a student is restricted to the time period specified for his section. Classes for a particular section are scheduled first, and then any courses being taken by individuals within a section, are scheduled around them. This is a very limiting feature. Conflicts cannot be resolved by postponing the course to another term. The student may not be able to work it into his already tight schedule, it may be a prerequisite course that he must have, or the department may not be planning to offer it for several terms hence. If a student were allowed to be placed in any time period available, over-all scheduling would be simplified.

It should be noted, however, that there is a reason for this policy, although it is, perhaps, being carried to an extreme. Certain courses are developed specifically for particular curricula, with the background of the students and the purpose of their course of study being taken into consideration. Therefore, it is highly desirable to schedule the section as a unit for the course. But, this is true for a limited number of courses, and it is a constraint which could possibly be reduced.

Another problem area encountered by the Scheduler is the number of options available within a curriculum, which results in small groups of three to six officers programmed for a course. This is considered un-economical and is to be avoided as far as possible; however, because of the diversity of the curriculum, the need for certain prerequisites, and the fact that many programs are adapted to individual, advanced students, the small groups do occur. The varied background of the students, a pre-determined course of study, and, in most cases, limited time allowed to complete a specified course of study, all compound the problem.

One other constraint placed upon the Scheduler is that one free morning or afternoon per week must be allotted to each section, so that aviators may schedule their required flight time. The Computer Facility is working on the development of a scheduling program.

Library. As discussed in Chapter V, the Library uses the computer system for two main purposes: bibliographic searches of technical reports, and listings of periodicals. Several other functions such as serial holdings and procurement processes, subscription renewals, and a combined list of periodical holdings (with the other participants being libraries affiliated with the West Coast Naval Laboratories) could conceivably lend themselves to data processing techniques.

The problem of circulation control, however, has a unique feature at the USNPGS. Most libraries are concerned only with which books are in circulation. Due to the limited shelf space available in the School's Library, students are encouraged to retain library books as long as they

are needed, or until they are recalled. Therefore, the School's Library must also know the name of the individual who has the book requested. The manual system currently employed by the Library for this function works very well; however, if the anticipated increase in student enrollment occurs, a different system may have to be used, and it may well be that the computer could be used to aid the situation.

II. MAJOR PROBLEM AREA

It is apparent from the study made, that there is much duplication of effort in maintaining information on the students enrolled in the various academic programs. Analysis of the requirements of these activities indicates numerous ways in which they could make use of a common data base of information on all officer students.

Curricular Offices. Two curricular offices were interviewed, Management and Operations Analysis and Baccalaureate/General Line.

The curricular office of the Business Administration and Economics Department maintains a file jacket for each student. All information concerning this individual is filed in this jacket: a copy of his orders, biography sheets, transcripts of previous academic work (copies forwarded from the Bureau of Naval Personnel), any correspondence from the student regarding his estimated time of arrival, etc.

Curricular officers divide the input of students into sections within a specific curriculum, attempting to obtain a cross-section of officers in each group, e.g., equal numbers of aviators, Supply Corps officers, Coast Guard officers, Marines, etc. It has been suggested that this procedure could be done by the computer, were there a common data base

of information already on file, according to pre-established criteria.

A cardex file of information is also maintained on each officer: Graduate Record Examination scores, undergraduate Quality Point Average, rank, designator, file number, and date of birth. From this file and other available information, several reports are compiled. One example of such a report is a list summarizing the following data: undergraduate school attended, degree awarded, and QPR, but not major field of study. These various items of information are gathered, evaluated and used in an attempt to determine where an officer may have difficulty in the course of study, etc. It should be noted that the Registrar also has much of this information already on file.

Additionally, during the school year, the curricular officer maintains the cumulative QPR for each student, over and above that maintained by the Registrar. Any statistical studies requested are compiled manually.

Various listings of students are received from the Registrar's office, and are used for reference and verification. However, they do not supplant those also produced by the curricular office. They are used primarily as check-off lists.

Prior to the end of a term in which there is to be a graduation, a list of those eligible for degrees and diplomas of completion, including those in the doubtful category, is required. This list of nominations, required not only of this curricular office but of all curricular offices, is based on QPR criteria, compiled manually, and forwarded to the Academic Council. Were the information readily available, in standardized format, in storage, the list could be run for the entire school, and thus relieve

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the individual offices of this responsibility.

The Baccalaureate/General Line curricular office must keep track of students in some fourteen different sections. Because many of these groups are scattered in various courses as sub-groups, a daily muster must be taken. This is accomplished by placing a mimeographed list on the bulletin board, and requiring the officers to initial it. When a sufficient number of changes have occurred, a new list is produced. These rosters are also used as check-off lists for various purposes.

Separate rosters are maintained for lecture attendance: one each for the BS and BA programs. Students are listed alphabetically regardless of section. Foreign students are not included in these listings, but are included in the section rosters.

In addition to the diploma listing described, a schedule of those completing the program is forwarded to the Bureau of Naval Personnel six months prior to graduation for the purpose of detailing. BS/BA students are sent, usually, for a two year period, however, some 40 to 50 percent of them graduate earlier, hence the need for the Bureau to know when the officers are available for re-assignment. (Theoretically, this is a duplication of effort for the information should be posted in the Officer Distribution Control Report, which is produced from information submitted by the Military Personnel Office. However, there is frequently a time delay of several months before this information is actually posted to the report used by the Detail Officers in the Bureau, hence the need for the advance information.)

Two other examples of listings which must be produced by the curricular office are the names of those who have completed requirements for the

Aviation Safety Center, and the names of those requiring Security Clearances which must be sent to the Military Personnel Office. All of these listings covered in the past few paragraphs give essentially the same information: name, rank, file number, designator, etc.

The uses of common data on all officer students enumerated for these two curricular offices are applicable to the other similar offices at the School. It may be assumed that differences in various programs may also cause more administrative requirements.

Were there a common data bank of information stored in the computer, changes could be submitted as they occur, either on punched cards or whatever medium is available, the data read into the computer updating the file, and then whenever a listing was required, it could be produced with a minimum of effort. Periodic listings and reports would be scheduled on a regular basis.

Military Personnel. The Military Personnel Office represents yet another example of duplication of effort. This office also maintains an IBM card file of information on all officer students. When the Bureau of Naval Personnel listing of officers selected to attend the Postgraduate School is received, office personnel, using Computer Facility equipment, punch an IBM card for each individual containing his name, rank, service, branch and curriculum number. As the actual orders on these officers are received, the cards are edited.

After the officer has reported aboard, his local address and telephone number plus the actual date on which he reported are also punched in the card. (Cards are also maintained on naval personnel attending the

Defense Language Institute, Monterey.)

The file is used to prepare student directories and security access lists. When an officer reports, his card is added to the file; when he is detached, it is removed. With officers arriving and departing throughout the school year, with peak periods occurring in December and July, this is a time-consuming process at best.

A major difficulty encountered by the Personnel Office is the lack of prompt notification by curricular offices of students changing from one program to another. These shifts may affect the officers's Tour Completion Date and this information must be reflected in the Officer Distribution Control Report (ODCR). If there were a common data bank of information on officer students with all changes being reported to it as they occurred, the problem would be greatly reduced. The Personnel Office could request an up-to-date listing of all students and their curricula once a month to use in verification of the ODCR. Changes would be noted and made. Security Clearance listings would also be simplified.

At present, any requests for statistical reports must be compiled manually, e.g., a count of those occupying government quarters, or how many officers have dependents residing in the area, etc. Having such data as this readily available, plus the capability to compile it quickly via a computer program, would eliminate many manhours of effort.

Textbook Library and NALF. Both of these activities also maintain IBM card files containing common data concerning officer students. Textbook Library procedures were described in Chapter V and while a more

streamlined system could be developed, no major problems are apparent. For example, a common data base could be used to establish the Textbook Libary file, eliminating the need to punch IBM cards on all officer students and staff.

As discussed in Chapter V, NALF prepares several IBM cards for each aviator, with all cards containing certain common items of information. One specific problem exists in that the input data cards for the Pilot's Log Program and the Station Master Log Program are very similar. It was pointed out that one source document contains all the information for both NALF Program inputs. Because the computer program requires a "matching" by name, rather than by a number, service number for example, there is not enough space on the cards to include all the information from the source document for both programs. An automated file containing all the required information would eliminate this duplication of effort.

III. A COMMON DATA BANK

It is apparent from the above discussion of problem areas, that a common data bank of information pertaining to all officer students would be of value and would eliminate much duplication of files now in existence.

Perhaps the greatest user of this data bank of information would be the Registrar. This office's current use of the computer system is discussed in Chapter V, and the procedures involved would be simplified by the establishment of a common data bank.

Additionally, the Monthly Training Report could be compiled by the computer rather than manually as is done now. While the report does not

contain a recapitulation of information on all officers undergoing instruction, it does include information on all students where changes have occurred, e.g., graduated, reported, changed programs, etc. It might even become possible to leave this data on a tape, rather than printing a report, and to transmit the tape to the Bureau of Naval Personnel to update their Officer's Master Record.

The Registrar is also responsible for administering various functions pertaining to officer students enrolled at civilian universities in programs under the cognizance of the USNPGS. These functions include contracting with the institution for the period of study (usually on a yearly basis), paying the necessary fees and book costs for each student, receiving grade reports, and in other ways administering their period of enrollment at that school. Estimates of the costs involved must be included in the USNPGS budget when submitted to the Bureau of Naval Personnel. Incorporation of this information in the data bank along with the data already available would supply the information needed for these reports and administrative tasks and would relieve the Registrar of much clerical work.

Thus, though numerous problem areas exist, and admittedly not all of them have been included in this study, it is evident that a common data base of officer student information is needed.

Information to be included in the Common Data Base. What information, then, should be included in this data base? While it is not the purpose of this study to design specifically the system or data base, certain items common to more than one area were found, and these should be considered in

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any preliminary design. They are: name; rank; file number; designator; service; section; student mail center number; library card number; aviator or non-aviator; local address; local telephone number; school code; curriculum code; date reported; date of birth; estimated tour completion date; undergraduate school attended: degree awarded, major field, quality point average; security clearance status; for this school: quality point average, number of hours of recitation and laboratory, number of credits (graduate and total); and so on. This list is by no means complete but it should give some idea of what is involved and what should be included.

Type of System. Present thinking indicates that random-access methods should be employed rather than sequential processing. Random-access offers a much faster and more efficient means of producing the wide variety of reports and information desired from the system. Also, the record of information on each individual should be of variable length, or a maximum of 200 characters. (A variable length record is one in which the number of characters or digits is not fixed, i.e., one record may contain 100 characters, and the next may contain 420 characters.)

To give an example of the type of equipment that could be employed, the IBM 1401 computer system will be used. An IBM 1311 Disk Storage Drive connected to the IBM 1401 has the capacity to store two million characters per disk pack storage cartridge. This would allow more than enough storage for the proposed data base: a rough estimate of the number of characters per record is 200, with the number of individuals to be included in the data base not exceeding 3500. Should other applications require additional capacity, a maximum of five Disk Storage Drives may be connected to the

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IBM 1401, allowing a capacity of ten million characters.

Summary. A common data base of information is only a beginning. Although a number of differences between this School and other civilian institutions employing educational data processing systems exist, some of their administrative applications could be adapted for use at the USNPGS.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Educational data processing systems have only begun to be developed. The processing capability of today's computers has thus far exceeded the user's ability to use them in their most sophisticated manner. A survey of the literature in this area indicates that there are numerous applications that could be adapted to the Postgraduate School.

In the development of any information system certain principles, objectives, etc., must be kept in mind. A number of these factors was discussed in Chapter III. A system study provides an opportunity for a comprehensive examination of an organization's information handling procedures, and as the first step in this study, a complete documentation of the present system is required. A description of the procedures and processes currently being performed on the computer is to be found in Chapter V.

Chapter VI enumerated the various differences between the USNPGS and other universities and colleges, and discussed the problem areas which will affect the development of any future system at the Postgraduate School.

Conclusions. A number of conclusions were reached in this study. They are (1) that an educational information system for the School is both feasible and desirable, and that systems currently employed at other institutions can provide guidelines in the design of such a system, taking into account the various differences and problem areas found in the study; (2) that a common data base of information is needed, and that not only

should this data base include officer students but that it should include all personnel (civilians, enlisted personnel, naval and marine personnel attending the Defense Language Institute, Monterey, staff, and NALF) connected with the Postgraduate School; (3) that establishment of this common data base would eliminate much of the duplication of effort currently in evidence; and (4) that this common data base could be used as the point of departure for various sub-systems such as a Textbook Library File which would eliminate the necessity of reading into the computer 20,000 IBM cards every time a listing was required, and an NALF file which would eliminate the numerous card files presently maintained.

Recommendations. Recommendations are divided into two sections: those concerning the common data base and educational information systems, and those pertaining to administration of the present system.

Those recommendations relating to development of the new system are (1) that further investigation be done on the design of a common data base of information; (2) that information already available in the Bureau of Naval Personnel Master File (automated) be taken from this file, stored on tape and transmitted to the School, either by communication or mail: this data could provide the basis of the common data base; (3) that further study is required in the following representative areas: information required for a simulation model of the School to be used in budget determinations, long-range planning, etc.; uses by the Medical and Disbursing departments, and others to provide, for example, a list of all those requiring annual physical examinations during a particular month for use as a check-off list; and the machine scoring and grading of objective type examinations; and (4) that if a common data base is approved as being economically

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feasible, that a separate administrative unit be established whose sole function would be to service the data base and the administrative system.

The following recommendations are made to aid administration of the present system: (1) that the purpose and specific objectives of the Computer Facility be stated in a Postgraduate School Instruction; (2) that priorities of processing and the policies relating thereto also be stated in writing; (3) that a schedule be established for the administrative users of the computer facilities, such a schedule to be flexible but that would provide a framework for the operation of the Facility; and (4) that all administrative users' computer programs be updated and completely documented.

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APPENDIX A

ORIGINAL INTERVIEW GUIDE

I. <u>General</u> <u>Information</u>

    1. What are the various jobs performed by the computer for this office?

    2. What are the specific requirements associated with these jobs?

    3. What is the time period for the information cycle?

    4. How long a time lag is permissable between the occurrence of an event or the information cycle and the reporting or feedback of the desired information?

    5. What sort of jobs might the computer be able to do to help you more with your work, it it were possible?

II. <u>Input</u> <u>Information</u>

    1. Sources of Inputs?

    2. What files are maintained?

3. What medium is used? (i.e., tape, cards, etc.)

4. Files contain what information?

5. Files are stored where?

6. Key punching is done by whom?

7. Run by run inputs?

8. Is information to be furnished as the data is generated (or manipulated by the computer) or is it to be supplied periodically?

III. Operations Required

1. What updating procedures do you employ?

2. How often is updating done?

3. What is entailed?

4. Are SORT/MERGE operations used?

5. How often?

6. Other operations or comments?

IV. <u>Output</u> <u>Information</u>

1. What are the standard outputs as the result of various runs?

2. What special outputs are required and how often?

3. Are standard forms used, or special paper?
   (i.e., in what form is information to be presented?)
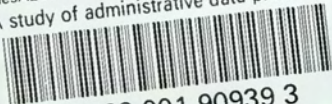
COMPUTER FACILITY EQUIPMENT LIST
(As of 1 July 1965)

1   CDC 1604 Computer

2   CDC 1607 Tape Units

1   CDC 405 Card Reader

1   CDC 1612 Printer

1   CDC 1614 (405) Controller

1   Ferranti Photo Electric Reader

1   Teletype Paper Tape Punch

1   IBM Monitoring Typewriter

1   IBM 1401 Computer

2   IBM 729 Tape Drives

1   IBM 1402 Card Read Punch

1   IBM 1403 Printer

1   IBM 1406 Auxiliary Storage

1   IBM 1311 Disk Master

1   IBM 1311 Disk Storage Drive Satellite

1   IBM 1051 Control Unit

1   IBM 1052 Printer Keyboard

5   IBM 1316 Disk Packs

1   IBM Disk Storage Adapter (1401)

1   IBM 1409 Console Auxiliary

1   IBM 1026 Transmission Control

1   IBM 1026 Line Adapter

1   IBM 1051 Line Adapter

1   CDC 160 Computer

1   CDC 163 Tape Drive

1   IBM 521 Electronic Calculating Punch

1   CDC 161 Typewriter Unit

1   CDC 165 Digital Recorder

1   IBM 514 Reproducer, Card

1   IBM 82 Sorter, Card

7   IBM 026 Card Punch Machines

5   Friden Flexowriters

2   IBM Interpreting Card Punch Machines

1   IBM 407 Accounting Machine