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AN INVESTIGATION OF CONVERSION ACTIVITIES IN SECOND TO THIRD GENERATION CHANGES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

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BY

NANCY SCHUETZE SAMPSON

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AN INVESTIGATION OF CONVERSION ACTIVITIES

IN SECOND TO THIRD GENERATION CHANGES

APPROVED BY

DISSERTATION COMMITTEE

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CHAPTER I

PURPOSE AND ORGANIZATION

Changing from one computer to another is a significant task. When two computers are not compatible, the complexity of the task multiplies. Third generation computers have brought about a mass change from the non-compatible second generation, thereby posing considerable problems for data processing managers.

Purpose of the Study

The object of this study is to provide a framework for the conversion project from the standpoint of the data processing manager. Various activities undertaken to complete conversion from one computer to another will be examined. The study is designed to identify and classify activities within the bounds of conversion from second generation machines to IBM System/360 models 30 and 40.

The study deals with conversion procedures as used by data processing managers. It is not designed to cost justify conversion efforts. Such evaluations are rightly a part of the feasibility study preceding the decision to order a computer, not of conversion itself. Knowledge

of the activities involved in conversion, however, may be used to aid future feasibility studies.

Importance of the Study

The study is of an exploratory nature and is designed to discover critical elements involved in conversions. No single definitive source gives the total picture of conversion from one computer to another non-compatible machine. With a new generation of equipment appearing every five to seven years, it is desirable to isolate the features of this particular process. Knowledge of the actual steps taken during conversion can be of great help to the data processing manager. Computer selection studies may, in the future, encompass a full concept of conversion and, therefore, become more complete. Preparation and implementation should then be more comprehensive and should allow for more thorough and realistic work schedules.

The complexity and duration of conversion have become matters of concern to data processing managers. Expansion of the data processing field indicates that future conversions can be expected.[1] A growing market for used computers indicates that there will be conversions to third generation equipment for some time to come. A thorough understanding of the conversion project will help managers make adequate preparation for these major changes.

Other evidence of the importance of knowing steps taken in conversion is an indication that its success is a predictor of future

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[1]The IBM System/370 was announced in July, 1970. It is still questionable whether or not System/370 represents a truly new generation.

operations. Poor conversions indicate inferior work and lead to operational problems, while efficient conversions lead to quality operations.[2] This observation, although originally applied to initial conversions from manual operations to a computer, is valid for changes from computer to computer as well. The tendency merely to move operations from one generation of computers to the next without essentially changing the logic or work flow emphasizes a need for adequate conversions at all times.[3]

Definition of Terms

While a glossary of terms unique to conversion appears in Appendix I, it is important to stress the concepts intended by "conversion" and "compatibility."

Conversion

As used in this study, "conversion" refers to activities directed toward changing from one computer to another. It may directly include some activities during pre-order feasibility studies, as long as these activities pertain to preparation for the change. It certainly includes all activities from the ordering of the new computer through its normal operations. This definition does not imply that, following the order, all time is devoted to conversion activity; but some of the events discussed will probably occur during the time span. "Conversion" will be defined as all activities associated with the change, not merely

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[2]Norman L. Enger, Putting MIS to Work (n.p.: American Management Association, 1969), p. 150.

[3]Paul T. Smith, Computers, Systems, and Profits (n.p.: American Management Association, 1969), p. 8.

conversion of a firm's applications. This concept of conversion is supported by W. J. Cartledge, Jr.'s definition: "Conversion begins when people are assigned to work specifically in this area. Conversion is completed when people are no longer involved with old programs."[4] This study includes new programs as a part of conversion when they are a part of the original plan. Cartledge's definition, then, applies but is narrower than the concept of conversion used here.

Compatibility

The more compatible two computers are, the easier it is to run programs written for one on the other. Completely compatible computers can handle each other's programs perfectly without modification. In actuality, complete compatibility has not occurred. Third generation computers are non-compatible with second generation machines. This means that far more than minimal change is required in moving from one to the other.

Another feature of compatibility is that computers are grouped by their manufacturers into "families" whose members can execute the same programs, within certain limits, without modification. The System/360 was designed as such a compatible family. "Within certain limits" must be stressed. Because various machines and core capacities allow for different operating systems, programs cannot be run interchangeably on all machines or even on any other machine without some modification.

Research Method

The purpose of this study is to provide a unified framework

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[4]W. J. Cartledge, Jr., "Program and File Conversion," Datamation, June, 1966, p. 22.

for computer conversion, a field which still lacks a comprehensive body of knowledge. In developing a new body of knowledge, the methods of basic research are appropriate. The objective of such research is to discover elements and critical relationships, not to test hypotheses statistically. In this study a general pattern of conversion is developed based on empirical situations. The important matter of the study, as in basic research, is the depth of the cases investigated, not sample sizes or statistical verification of chosen situations.

Each conversion has been studied as a case. The case method of research, possible only in practice, is correct when numerous complex interrelationships are difficult to understand.[5] It is impossible to test the theoretical conclusions without enacting a real conversion.

Specifically, techniques used by zoologists and biologists are applied to the conversion project. The techniques of taxonomy and ordering are rightly applied to classifying descriptions of observations. While the techniques of science are applied to natural phenomena and living elements, they are also applicable, with modification, to the study of other than living creatures. The activities of the conversions investigated have been isolated, described, and ordered for analysis.

Personal interviews were conducted with data processing managers to obtain information on conversion activities planned and actually conducted. Actual conversions were thoroughly investigated. A

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[5]Harper W. Boyd, Jr. and Ralph Westfall, Marketing Research Text and Cases (Homewood, Ill.: Richard D. Irwin, Inc.), 1964, p. 61.

preliminary survey showed that a structured questionnaire format was inadequate to obtain the depth and variety of information desired. Interviews and discussions were directed with in-depth, open-ended questions to make sure that certain areas were covered. These areas included: equipment configurations, order and installation dates, applications, conversions, training inside and outside the department, facilities preparations, planning, implementation, and current status. If certain areas were not otherwise mentioned in open discussion, they were probed. Open discussion, however, was the key to obtaining many details which the data processing manager thought particularly unique to his own situation. This approach is entirely consistent with scientific taxonomy. As John R. Gregg states:

> It is never possible . . . to guarantee the success of a taxonomic research program by setting down antecedent directives that are then to be followed out, step by step, until the requisite discoveries have been made.[6]

The procedure of combining free discussion with comment on specific areas of importance makes the study as comprehensive as possible; it neither limits the responses, nor completely forces specific areas of response.

The method of analysis used for the study is basically analogy. It is the normal analysis used in conjunction with case or descriptive research.[7] In analogy, the significant features of each element are determined. The features are then compared with all others found. Similarities, dissimilarities and totally unique aspects are noted. In practice this meant that the events of the conversions were conceptually

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[6]John R. Gregg, The Language of Taxonomy (n.p.: Columbia University Press, 1964), p. 30.

[7]Boyd and Westfall, Marketing Research, p. 62.

broken down into individual activities and rebuilt within major categories. Again this method is consistent with taxonomic studies:

> A taxonomic system is a structure obtainable by successively partitioning some initial set of organisms into subsets each of which belongs to some taxonomic category.[8]

The conversion has been broken down into numerous activities, each of which belongs to some major area of the conversion project. Certainly the activities noted are not mutually exclusive. Taxonomic categories, likewise, are not necessarily mutually exclusive.[9]

Scope of the Study

While there are articles suggesting various approaches to different aspects of conversion from second to third generation computers, several must be pieced together in order to obtain a complete picture. An extensive review of the literature revealed no study which dealt with several conversions. The present study investigates the conversions of twenty-eight firms in a major urban area of a Southwestern state. The information collected falls into four major groups: the computer system, the applications, the people involved, and planning and implementation of the conversion. Tables I-IV contain breakdowns of the main areas of classification and provide more explicit evidence of the scope of the study. The percentages within the table indicate the breakdown of the data processing managers' responses.

Limitations of the Study

The conclusions of this study are limited by various restrictions

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[8]Gregg, Language of Taxonomy, p. 33.

[9]Ibid., p. 67.

TABLE I

MAIN ACTIVITY BREAKDOWN WITHIN
COMPUTER SYSTEM ACTIVITIES

Main Activity Event Areas:	User Action	User Percentage
Hardware Activity		
Old Equipment:	Released within first month	68%
	Released Eventually	11%
	Retained	14%
New Equipment:	Current Configuration not as original	96%
	Planned Configuration change	22%
Site Preparation:	Completed by delivery	100%
Software Activity		
Operating System Decision:	Adequate for first year	93%
Programming Language Decision:	Adequate, first year	93%
	Adequate first two years	90%
Emulation:	Planned some use	93%
	Extensive modification Required	32%
Data Base Activity		
Only general comments on importance		
Supported Systems Activity		
Policy to use current, supported systems releases		90%

TABLE II

MAIN ACTIVITY BREAKDOWN WITHIN APPLICATIONS
CONVERSION ACTIVITIES

Main Activity Event Areas:	User Action	User Percentage
Program Conversion		
General Objectives:	Based on hardware	46%
	Based on hardware, new applications	40%
	Based on software, new applications	14%
Conversion Approach:	Emulation totally & permanently	22%
	Some emulation permanently	25%
	Intermediate emulation	50%
	All new or redesigned systems	3%
File Conversion		
Media Changes		100%
Data Changes for Emulation		14%
Standards		
Technical:	As conversion guide	25%
	Developed during conversion	25%
Operations:	To guide conversion/future	14%
	Developed during/after conversion	14%
Documentation:	Second generation adequate	28%
	Developed for third generation	86%
Testing		
Prime Concern:	Emulator or emulation applications	25%
	Parallel Operations	36%
Timing:	Pre and Post Installation Testing	61%
	Post Installation Testing Only	39%

TABLE III

MAIN ACTIVITY BREAKDOWN WITHIN ACTIVITIES
CONCERNING PEOPLE AND ORGANIZATION

Main Activity Event Areas:	User Action	User Percentage
Personnel Activities		
Staffing:	Increases	36%
	Permanent Changes	50%
	Temporary Changes	7%
Training:	Managers, EDP	46%
	Systems & Programming	100%
	Operators	50%
	Other EDP Staff	4%
	Outside EDP	46%
EDP Organization Activity		
Created separate group for conversion work		25%
Positions Added/Created:	Middle Management	14%
	Software Specialists	22%
	Conversion Teams	11%
	I/O Control	11%
	Entire Organization	11%
Company-Wide Organization		
Major, Unanticipated Changes of Priority		14%
Company-Wide Support of Conversion		28%
Managerial Decisions Related to Staffing/Conversion Method:		
	Aided Conversion	11%
	Hindered Conversion	7%

TABLE IV

MAIN ACTIVITY BREAKDOWN WITHIN PLANNING, IMPLEMENTING, AND EVALUATING ACTIVITIES

Main Activity Event Areas:	User Action	User Percentage
Objectives	Clearly Stated	32%
Plan		
Formality:	Written	43%
	Partly Written	25%
Techniques:	Automated PERT	4%
	Charting	7%
Updating:	Of Written Plans	92%
	Of Partly-Written Plans	29%
Retention:	Of Written Plans	72%
	Of Partly-Written Plans	29%
Time Frame:	Short-Range (Initially 39%) Actually	14%
	Long-Range With Target Dates	40%
	Long-Range Without Target Dates	21%
Use of Order-Delivery Lag Time:	Last 30%	18%
	Last 50-75%	25%
	More than 90%	32%
Schedule Basis:	Installation Date for Facilities	100%
	Before Need for Training	100%
	Applications Priority with Dates	43%
	Applications Priority, No Dates	14%
	No Order, No Target Dates	43%
Implementation and Evaluation		
Evaluated Implementation Via Control Techniques:		
	Some Attempt	32%
	No Attempt	36%

arising from both the group selected for study and the procedures used in collection and analysis of the information. All generalizations expressed must be tempered by knowledge of these factors.

Limitations to the study include the following: the geographical area, the equipment considered, the computer users, the people interviewed, the type of sample, and time.

Geographical Area

The sample was selected from a population and commercial center in a Southwestern state. The same area has been analyzed frequently for marketing and other commercial surveys. A concentration of computer users in the area allows variety and interplay of experiences from which to draw.[10] However, the conversions in the area are not necessarily representative of all second to third generations either in the United States or the world. This should be kept in mind in drawing conclusions from the study.

Equipment

Conversions from second generation machines to System/360 Models 30 and 40 were investigated. A sample of other conversions to third generation computers might uncover another pattern of conversion activities. If there is a difference, then this study is not representative

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[10] Of the user group specified to make up the sample for this study, 36 per cent of the specified users in the state lie within the selected geographical area. Another 30 per cent is concentrated in a second population center in the state, and the rest of the specified users are scattered throughout the state in no great concentration. Derived from: Norman C. Whitehorn (ed.), Directory of Computer Facilities in Texas (College Station, Texas: Industrial Economics Research Division, Texas Engineering Experiment Station, Texas A&M University), June, 1970.

of all conversions, but it is probably representative of medium scale second generation computers to Models 30 and 40 in the area. The situations investigated, however, are representative of non-compatible conversions. IBM set the pace, and third generation is now frequently defined in terms of System/360.[11] Models 30 and 40 account for nearly 90 per cent of the 360 equipment in operation at the time of this study.[12] Users of this scale of equipment have relatively similar volume demands, operating problems, and staffing problems. The widespread use of these models and their similarity provide the rationale for limiting the study to them.

The Users

The target group for the study was medium scale, commercial users with in-house equipment. A normal distinction is made between commercial and scientific users. The two use different programming languages and implement significantly different applications. Scientific users have long used FORTRAN, a standard, high-level language. Continued use of FORTRAN precludes the necessity of recoding programs and learning a new language to complete conversions to third generation. Commercial users, however, have not been using a standard programming language. This fact has led to considerable complexity in conversions.

The commercial user is further distinguished from the manufacturer software house, and computer utility. The latter group is mainly

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[11] Fred Gruenberger, "The Shakedown Decade," Datamation, January, 1970, p. 71.

[12] Based on figures from Niel MacDonald, "Monthly Computer Census," Computers and Automation, Vol. XIX, No. 3 (1970), pp. 59-61. Manufacturers make neither the number of their installations nor their users publically known, so the census is an estimate.

in an advisory position concerning conversions. They do not necessarily have to live with the day-to-day results of the conversion. In the case of manufacturers, information would be biased toward outstanding conversion efforts or toward some ideal situation. The goal of this study is to isolate and analyze what actually occurred during the conversion process. Software houses and utilities, generally providing programming services or machine time, are not intimately involved with the entire conversion situation as experienced by the in-house user. Aspects such as orientation, training, and facilities planning are not of primary concern to them.

Manufacturers, financial institutions, wholesale-retail concerns, and other non-scientific users were investigated. This group employs common applications such as accounting, budgeting, payroll, and management information reporting. Schools, municipalities, and hospitals use similar applications. They, however, are very specialized in unique and significant applications as computer-aided instruction, tax calculation, and scheduling systems. The latter group is not included in the target group.

People Interviewed

Restricting interviews to data processing managers is also a limitation to the study. Others in data processing may be aware of various technical difficulties; yet it is the data processing department manager who must observe the conversion as a totality from the decision to order through the evaluation of the entire effort. The researcher may be handicapped by the information presented as well as that withheld. Information which might make the data processing manager and his conversion

look good may have been emphasized. Other information may have been shaded or not presented at all. Some areas met with non-response, although there was no pattern to these. The researcher must rely on the information given, interpreting it to the best of his ability. Efforts were made to eliminate areas of non-response and encourage comprehensiveness and understanding during the personal interviews.

The Sample

Another limitation to the study is the use of a non-probability, convenience sample rather than a random sample of commercial user conversions. Non-probability samples are correctly used in exploratory surveys where the aim is to probe for different explanations. Furthermore, the case method of descriptive research is one of in-depth study of a relatively small number of cases. Emphasis is on completeness and understanding relationships, regardless of the number of cases studied.[13]

An effort was made to contact all those engaged in applicable conversions within the geographical area. Locating those who have converted or are converting to a particular machine from second generation computers is made particularly difficult by the fact that no listings are available from the manufacturer, the Data Processing Management Association local groups, local or state tax records, or any periodicals. The only listing available was one prepared by a research division of a state university.[14] It was used as a basis for selection; however, it was incomplete and inadequate for the task at hand.

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[13]Boyd and Westfall, Marketing Research, pp. 60-61.

[14]Whitehorn, "Computer Facilities in Texas."

Only current equipment configurations of questionnaire respondents were listed. The respondents did not constitute the universe of installations within the state. There was no means of determining previous equipment, either second generation or the first System/360 configuration used. The list, however, was current and the only one available. It served as a basis for locating users. Knowledge provided by the initial group led to other applicable users.

Circumstances within the data processing field, therefore, mean that a convenience sample is the only one feasible. It would be extremely difficult and impractical to get a truly random sample of second generation to Models 30 and 40 conversions, or a random sample of any other group of conversions. Efforts were made to avoid intentional bias, as every applicable conversion within the area was included either in the main study or in the preliminary research.

System/360 was announced in 1964 and was obtained by some users in 1966; therefore, some conversions may reasonably have been completed in 1966. The time span investigated is from June, 1964, through June, 1966. Conversions occurred throughout the time period. Some facets of the more distant conversions will have been forgotten; yet the multitude of detail concerning more recent conversions will act as a balance.

Limitations inherent in the method of research and analysis have been presented in this section. Any conclusions and generalizations from this study must be taken in light of the limitations indicated above.

Organization of the Study

The remainder of the study falls into three main areas: background, information gathered, and conclusions. Each area is described.

Chapter II describes a historical background vital to understanding the concept of conversion from one generation of computers to another, and to the situation represented in this study. It also contains a review of the literature directly related to conversion projects.

The second main area includes four chapters on the information acquired. The chapters develop and describe the activities included in the framework of the conversion project. Chapter III describes the role of the computer system and decisions concerning it in respect to the entire conversion. Program conversion, file conversion, and the roles of standards and testing are presented in Chapter IV. The fifth chapter contains information concerning the human aspect of conversion: who is involved, how the people are trained, and how they are organized. Planning, implementing and evaluating the conversion are discussed in Chapter VI. Applicable parts of the literature available are presented as the observed activities are explained.

Chapter VII is the final section. It summarizes and concludes the study and indicates possible areas of future research. Also included are a number of recommendations directed toward data processing managers.

Two appendices contain supplementary information. The first is a glossary of terms used particularly in connection with conversions. The second appendix includes the conversion cases investigated.

CHAPTER II

BACKGROUND AND REVIEW OF CONVERSION LITERATURE

Background

Knowing what characteristics identify the different computer generations helps put second to third generation conversions in their proper setting. Although some controversy exists as to exactly what constitutes a new generation, the elements differentiating them as presented in this study are fairly well accepted. Basically, the first three computer generations have been separated according to unique physical properties or specific hardware characteristics. The first generation computers were large cumbersome pieces of gear whose circuits were completed with the use of a multitude of vacuum tubes. The size of the tubes alone called for a large computer, and they produced a great deal of heat. UNIVAC I was the first commercially available computer. In 1950 the United States Census Bureau was the first to use that machine; however, it was not generally available until 1952. Second generation computers appeared in 1958 and 1959. The circuitry was transistorized and produced considerably less heat. The machines were also more reliable and required less power. Third generation computers became available in 1965 and provided yet another advance in basic circuits. Microelectronic manufacturing techniques provided smaller, faster circuits

in modular packages. Third generation computers equipment had larger and higher-speed internal memories, allowing larger and more complex programs. Likewise, larger and more reliable random access storage devices were provided.[1]

Software features have not been so easily assigned to different generations, except that the capabilities offered with third generation are perhaps its most notable characteristics. While some features of an operating system came into play with later second generation machines, the third generation brought the full concept of an operating system into being. Greatly increased sophistication and complexities in operating systems appeared with third generation machines. The operating systems were designed for extensive use in multi-programming, multiprocessing, and data communications. File management software systems were also a vastly improved third generation feature.[2] High level programming languages also began appearing with some of the second generation machines. The general acceptance of a standard commercial programming language, however, was particularly noted with the compilers.

The operating system and, under System/360, the language to control it provided a new operating environment for the users, the job stream. Operations in the previous generations were basically carried out as separate jobs, i.e., every program represented a different "job" and was a separate entity. It was started, run, and completed with its own input and output. Under the job stream concept, it is possible to

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[1]Enger, Putting MIS to Work, pp. 190-91; Richard G. Canning and Roger L. Sission, The Management of Data Processing, (New York: John Wiley & Sons, Inc., 1967), p. 4.

[2]Ibid., p. 191.

string a number of programs together in a series without stopping and starting the machine anew for each operation. Data files for intermediate steps can be passed along throughout the stream with only the initial input and final output files being maintained on some media for a period of time. A simple example is illustrated by the operation of a payroll system involving many programs. Second generation operating environment would mean that each program was set up and run separately; however, only one set-up would be required to run the entire job stream in a third generation operating environment.

The job stream concept would seem to require less operator intervention, and many installations had anticipated just that. The only jobs set up were to run as streams, requiring less initiation, duplicate tape mountings, and other operator work. However, the operating system needed operator responses of a significantly greater sophistication than had been known before. The net result was that perhaps more skilled operator intervention was actually required.

A certain characteristic of third generation is particularly noteworthy--that is, the logic of System/360. Gruenberger feels the 360 logic is the industry's most significant improvement in the 1960's in data processing. He indicates that soundness of design is emphasized by widespread copying of the 360 design.[3]

It must also be pointed out that the third generation equipment provided increased speed of operations at reduced cost.[4] This was especially true in relation to IBM-1401 to System/360, Model 30 changes. The

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[3]Gruenberger, "The Shakedown Decade," p. 71.

[4]Enger, Putting MIS to Work, p. 191.

1401 operations were faster on the Mod 30 even when emulation mode was used. Because 1401's were widely utilized by the users investigated for this study, this factor cannot be overlooked in a complete review of the conversions. This meant that many could justify considering the Model 30 as a big, fast 1401, for the time being, anyway.

The storage devices of third generation equipment provide changes of degree and flexibility from second generation devices. The equipment defined by this study are used as specific examples. Different models of the 1401 came with-card only storage, card and tape storage, or card and disk storage. No card only capabilities are provided by Models 30 and 40, but it is possible to use cards, tapes, and disks all on the same main computer. The devices offer increased speed. The disks also provide new concepts of data storage.

Data transmission and communications were greatly improved on third generation equipment. A more diversified set of I/O devices and expanded random access storage made the improved communications possible. Some users began communications data processing on the 1460 and were ready for the advancements provided by System/360.

The number of changes which came about with third generation as well as complexity and vastly increased sophistication combine to make the change from second to third generation more significant than previous changes. Canning and Sission projected the magnitude of the change in the very early stages:

> It appears to us that the transition from the second to the third generation of computers is potentially a greater jump than the transition from tabulating machines to computers or between first and second generation computers. Considerable difficulty was experienced in converting to computers in the first place--and we foresee potentially

> greater difficulties just ahead.[5] . . .
> . . . . . .
> This is not just because of hardware advances--although these are important. But it is also due to the state of the art that has been reached in software, applications packages, and sophisticated uses. All of these things tie together to provide the user with a much more powerful tool than he has had previously with computers.[6]

Never before had so many conversions taken place in such a concentrated period of time. Prior conversions had generally been individual, scattered efforts. Also prior conversions frequently occurred among compatible computers within the same family. In IBM families, as a more powerful computer was required, a user could change from a 704 to a 709 or to a 7090, or from a 1401 to a 1410 and still be within a compatible family.[7] Similar situations were true for other manufacturers.

The conversions from second to third generation computers also represent the first time that many previously trained personnel were available to carry out the conversions. While the programmers, systems analysts, and operators did not require training to introduce them to basic concepts of data processing, much of the third generation thinking was not founded in the second generation environment. User sophistication had to increase as well to match the capabilities of the equipment and its software.[8] Such changes do not come easily or quickly.

Third generation computers, then, presented a new level of change on a mass basis among computer users. It is now possible to

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[5] Canning and Sission, Management of Data Processing, p. 1.

[6] Ibid., p. 112.

[7] Richard G. Canning (ed.), "Conversion to a Non-Compatible Computer," EDP Analyzer, December, 1964, p. 3.

[8] Enger, Putting MIS to Work, p. 201.

view the literature available on conversion with an understanding of the differences between second and third generation computers.

Review of Conversion Literature

The literature in the area of non-compatible computer conversions was particularly concentrated during the early implementations of third generation computer systems. Prior to that time, conversion literature primarily pertained to conversions from manual operations to some computer system. In both areas, initial conversion to computer usage and second to third generation changes, the literature has been limited to parts of books and articles in periodicals. The literature has been divided into three main areas for analysis in this study: (1) general information concerning the area of conversion; (2) specific topics covered relating to parts of the conversion project; and (3) conversion case studies.

General Information

Literature presented under the heading of "General Information" falls into two groupings: initial conversions to computers, and second to third generation conversions. These works come the closest to the covering of the total concept of the conversion project.

Entire sections of two books were devoted to initial conversion projects. While the information pertains directly to the first-time conversion, the steps involved are indicative of those to be followed in conversions between computers. The first presentation considered describes the main phases of getting a computer system installed and operating.[9]

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[9]Irving I. Solomon and Laurence O. Weingart, Management Uses of the Computer (New York: Harper & Row, Publishers, 1966), pp. 149-86.

The preparatory phase is seen as the final stages of design following the feasibility study. The activities noted are personnel selection and training, applications programming, master file conversion, and site preparation. This phase is normally completed with the delivery date. The importance of developing and enforcing standards and of complete documentation at the time of programming are stressed. The second main phase includes activities related to the change-over: equipment and applications testing, including comparison with the manual method. The final phase is a continuing one of monitoring the systems (especially in relation to company growth and change) in order to keep them up to date.

Another presentation deals especially with computer to computer conversion. The conversion activities are seen as separate from personnel, planning, and site preparation activities.[10] The conversion is viewed as a final change-over of files and applications to operation on a computer. Preparation activities are divided into three categories. The first is general, including selection and training of personnel, scheduling and control, and systems analysis and programming. Special emphasis is placed on a work-in-process report which can be used as a control device covering the allocated and expended hours on a certain project. The second category of preparation activity covers elements directly related to the change-over: master file conversions, present method cut-offs, documentation of procedures, notification of all people involved, and synchronized procedures and instructions releases. Site preparation is the third category and includes the consideration of

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[10]Robert Van Ness, Principles of Data Processing with Computers (Elmhurst, Ill.: The Business Press, 1966).

space, location, construction costs, environment control, electricity, flooring, emergency precautions, and storage areas. A general time estimate is given showing the preparation activities to take about nine months, and the change-over, or conversion, as the writer calls it, two months. Three methods of conversion from one computer to another are discussed and rated according to desirability: (1) gradual applications conversion on a like computer outside; (2) overlap of old and new computers in house during applications conversions; (3) immediate applications change-over as old equipment is removed and new comes in. The idea of documenting the change, or transition, phase is also stressed, especially because it is frequently overlooked. Other factors cited as keys to successful change-overs include thorough systems design, programming and testing; good documentation; thorough advance planning of the schedule; and competent decision-making and supervision.

Two articles were found to have information identifying the activities of the total conversion project, specifically directed toward second to third generation changes. Although one was designed to identify cost areas, in doing so it identifies areas of conversion activity.[11] The main areas identified are management planning, training, procedures and forms, re-evaluation or redefinition of systems design and program conversion methods, file conversion, equipment installation, and software conversions. Important elements within these activities were also identified. This approach is, again, intended to identify conversion cost areas. In doing so, not all activities related to the entire conversion project are included, because some seemed to be chargeable to

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[11] D. M. Baker, "Economic Considerations of Conversion," Datamation, June, 1966, pp. 30-34.

other accounts. Work on intermediate and new systems are very obvious cases in point. The other article identifies major activities to include in conversion planning physical layout, testing and debugging applications programs, training, and an over-all meshing of hardware factors and programs.[12] While these principal activities were described, the main purpose of the article was to encourage data processing managers to use critical path planning methods to direct all their conversion efforts; very few activity breakdowns or explanations were included.

Specific Topics

The largest portion of the literature related to conversion projects is in the form of articles covering specific topics, or segments of the whole conversion. The following specific topics are discussed here: the feasibility study, program and file conversion, and indirectly related areas. The last two are reviewed further, as are other special topics from literature, wherever they become relevant to the findings of the study.

The Feasibility Study. Literature in the area of the feasibility study is considerably more abundant than is material in the area of conversion. It is mentioned here for three reasons: (1) to indicate the role of the feasibility study in the entire process of changing from one computer to another, i.e., preceding the order and direct conversion activities; (2) to indicate the relative importance of the feasibility study indicated in literature in comparison with literature directed toward understanding the conversion project; (3) to indicate the somewhat related research done concerning the feasibility study.

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[12]"Countdown to Installation," Data Processor, April, 1966, pp. 10-12.

At least two entire books have been devoted to the feasibility study which precedes ordering a computer. One is basically the presentation of a systems study for computer acquisition and selection.[13] Some of the selection criteria serve well as indicators in conversion; however, the presentation covers selection and procurement only. It does not attempt to cover any other aspects, such as conversion planning and preparation, some of which can occur during the feasibility stage. The second book is based on a study of 100 small Texas firms.[14] The study was designed to provide an approach which would help small businesses decide if they could justify the use of a computer, based on the use of feasibility studies. A checklist of things which a manager of a small business should consider in a feasibility study is included. The findings of the study show that half the concerns did not even make feasibility studies "worthy of the name." The lack of thoroughness in the feasibility study may show how much thoroughness to expect in the conversion stage. Although the sample was taken only from first time conversions, the findings may apply to later conversions as well. The cases investigated in this study include small and medium businesses, many of which are similar to those used in the feasibility study research.

An article published at the time System/360 was announced proposed a number of conversion cost areas to be considered in a feasibility study.[15] The cost areas show activities which can be directly costed to

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[13]Edward O. Joslin, Computer Selection (Reading, Mass.: Addison-Wesley Publishing Company, Inc., 1968).

[14]Donald H. Sanders, Introducing Computers to Small Business, (Park Ridge, Ill.: Data Processing Management Association, 1966).

[15]David L. Harvey, "Considerations in Making a Feasibility Study," Data Processing, Vol. IV, 1964, pp. 272-79.

conversion and include: personnel, site preparation, auxiliary equipment and tapes, equipment rental for testing, duplicate rental during conversion, and file conversion. The personnel area is further broken down into supervision, training, systems design, flow charting, programming, debugging, testing, conversion planning and other. These cost areas, again, indicate some of the major activities included, but these are not described. The areas are restricted to elements which can be costed to conversion in an accounting sense, and therefore present an incomplete picture of the entire conversion project.

Program and File Conversion. Much of the literature on conversion has been directly related to the area of program and file conversion. Certainly, the area deserves a good deal of attention, but it cannot be construed as the only area of activity to consider for a conversion from one computer to another. Three very comprehensive articles have appeared since the announcement of System/360. While one of them is written in tones of general computer to computer conversions, all are primarily directed to conversions from one computer, likely second generation, to a third generation computer.

One authoritative article on non-compatible conversions was written shortly after System/360 was announced, and well before anyone had acquired this computer.[16] The publication time is here noted, not to invalidate the information, but to emphasize that the presentation was more or less predictive. The presentation covers a range of activities, from reasons why the conversions would occur to a suggested planning approach. The elements of the most simple conversion, a replacement of the old

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[16]Canning, "Conversion."

computer, are identified as current, interim, and new programs, one for production and one for conversion; and a squeeze in the time schedule. The program conversion approaches discussed include the use of emulators, simulators, automatic translators and manual reprogramming. A current inventory of programs, including production data, is cited as essential to developing a priority basis. Conversion problems are said to be eased by bringing documentation packages up to date, deciding whether or not to design more integrated systems, beginning to manually reprogram priority programs as soon as possible, and remembering to maintain both the production and conversion versions of the program. It is suggested that old programs could be run on time, leased outside, with an emulator, or simulator, or by buying the old computer. Use of machine-independent language, such as COBOL, was recommended for interim programs. File conversion considerations included redefinition, reorganization, the new collation sequence, and the nine-track tape drives. It is also suggested to know exactly what the manufacturer's schedule is for various hardware and software features. The use of PERT planning is highly recommended to develop a reasonable, workable plan which does not overlook essential activities.

One of the best discussions of program and file conversions presents various pros and cons on different techniques and concludes by showing how all the activities of conversion were used in a large scale conversion project.[17] The discussion includes organizational aspects of assigning conversion programs, planning and control, and procedures for program and file conversions. A number of check lists are included to

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[17]Cartledge, "Program and File Conversion," pp. 22-27.

suggest possible conversion tasks and work elements for applications broken into programs with the required files. Information from complete documentation packages, program functions, interfaces, file compositions, operations data, and user's intended changes are needed to determine the appropriate conversion method for each program. The various methods of conversion for programs and files are discussed. Emphasis is placed on an early analysis of the conversion load and plan development. The plan should include knowledge of available conversion aids, a priority schedule of applications, conversion policies and standards, a schedule of activities, target dates, and a checklist of the tasks. A suggested list of activities to be scheduled includes the following: applications and programs; operator and programmer training; conversion utilities; information required from the manufacturer; implementation of the operating system, built to specific needs; remote testing; file conversion activities before and after delivery; and procurement of tapes, disc packs, and other supplies.

The main purpose of another article is to evaluate the various methods of program conversion and suggest a means of selecting the best one for the program.[18] Cost-resource trade-offs were developed for each conversion method based on how much design, programming, check-out and implementation work was required. By balancing the trade-offs with the expected life of the program, the best conversion method may be selected. The general attitude expressed toward emulation as a long-run approach was that it hinders the user firm's operations, programming and possibly

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[18]Paul G. Kahn and Mary E. Fuller, "Program Conversion," Data Processing Magazine, November, 1969, pp. 28-31.

machine efficiency. A number of factors were suggested as important to evaluate in the development of the plan for program conversions: (1) source and target language and operating system; (2) scheduling; (3) manpower availability, requirements, and organization; production data; quali- (5) quality of documentation; (6) quality and reliability of source programs; (7) data transmission time and cost estimates; (8) file conversion approach; (9) operator and programmer training; (10) facilities management on new system; (11) forecast of new production load; (12) programming techniques for new system; quality assurance plans during conversion.

The arguments and suggestions presented in these articles are well founded and complete within the realm of program and file conversion activities. This study includes the activities of program and file conversion and bases the findings on several real conversions. Thus, insight has been gained by carrying out suggested activities of these presentations.

Indirect Areas. Some literature on aspects of the conversion project is not as directly related to the conversion projects, as were the preceding presentations. One such presentation is primarily concerned with the role of computers and systems in the firm.[19] A number of points in the presentation are especially important at the time of a conversion. The primary emphasis is designing systems which balance the needs of the firm, and the requirements of the computer through systems thinking, adequate to both the needs and the computer. Special emphasis is given to the fact that systems, the thinking involved, and the results, have not kept pace with the high-powered logic of new computers. Conversion projects tend to end up with old approaches "re-invented" on the new

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[19]Smith, Computers Systems.

computer. This tendency is attacked in the study. Another area stressed and particularly applicable to conversion involves fostering support for the project. Basically, those who use a system have to want it to work before it will work. Two specific areas of training are cited as vital to automated business systems, training for management personnel and for systems analysts. The essential education for management is knowledge of the relationship between systems and computers and basic knowledge of the computer's makeup. Emphasis is also placed on systems designers' knowing the business, not just systems.

Another presentation includes information which can be adapted to the entire conversion project.[20] The guidelines developed are for programming projects, but can be applied to conversion, if we keep in mind all non-programming activities as well. The foundation steps include: analyzing what is to be done; planning the work by task, time, and total pattern; determining staffing and computer requirements; and setting up reviews, checkpoints, and communications channels. The importance of formal standards is also stressed as a key to success. Again, the presentation was designed for programming projects, but is applicable to a degree because conversion is an EDP project involving programming.

Two presentations intended primarily for systems analysis aspects include occasional direct remarks concerning conversions. Some comments in one are directed toward management information systems and are especially directed toward third generation conversions.[21] Specific comments are made on the necessity of control procedures for conversion and topics

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[20]Charles Phillip Lecht, The Management of Computer Programming Projects (n.p.: American Management Association, 1967).

[21]Enger, Putting MIS to Work.

of support evaluation to be considered in the feasibility study. Management's responsibilities and the need for planning and coordination are stressed in relation to the conversion project. Another presentation on the systems function includes a few comments on conversion in general, especially the tendency to repeat old jobs on new computers with only minor changes.[22] The discussion on implementing new systems mentions factors applicable to conversion projects such as the necessity of successful training and the introduction of everyone to the system in the proper degree.

Case Presentations

The case presentations found in literature are of interest, because they are most representative of the descriptive approach taken for this study. Two of the presentations involve the type of conversions defined as the sample group for this study. Both are very brief. One contains basic information on the machine configurations and planned configurations and lists only a few activities undertaken.[23] Training activities were mentioned as a two-week seminar immediately preceding installation, conducted by the Systems Engineer, and outside classes for the programmers at the Education Center following the computer's installation. Two months of parallel tests were run before completely changing the applications over to the new computer. All new program development was delayed until three months following installation. The other medium scale

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[22]Frank Greenwood, Managing the Systems Analysis Function (n.p.: American Management Association, 1968).

[23]"A Central System for a Growing Company," Data Processor, April, 1966, pp. 6-9.

conversion case presentation contained primarily decision activities during the preliminary planning stages of the conversion.[24] Four main conversion objectives were presented. Attention was directed toward the conversion team which was established to handle necessary activities. The basic approach to the applications conversion was twofold: (1) a thorough plan was developed including applicable systems methods and objectives and made use of key personnel in the user departments; and (2) work was organized to move from simple to complex programming tasks. Cooperation among data processing, management, and operations personnel was indicated as important throughout the planning and implementation. The plan included written details of data sources, data storage and handling, run procedures, run sequences, forms and layouts. Neither of the case situations was a complete picture of the conversion. The purpose of the presentations must also be noted. Both appeared in an IBM publication and seem to be primarily intended to show quick, smooth physical and applications changeovers to third generation. Only very general activities leading up to and following the physical change were indicated.

One case presentation comprehensively covered the applications and training phases of a large scale, scientific conversion from second to third generation computers.[25] The critical activities of the conversion were described and a conclusion cited factors which particularly aided in making a smooth conversion. Preliminary activities included

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[24]"Weekend Conversion at Wood Brothers," Data Processor, February, 1968, pp. 7-8.

[25]Douglas A. Williams, "Conversion at Lockheed Missiles and Space," Datamation, January, 1967, pp. 39-41.

developing a formal statement of computer replacement criteria, feasibility study, and the use of an interim machine. The specific conversion activities included personnel organization and training; a work load survey; in-house software conversion preparations; in-house systems work; and test facilities on a like machine. The assignment of a conversion project manager and the organization of a conversion team were particularly advantageous. Training included languages and the operating system for both programmers and operators. The documentation of other conversions and technical bulletins served as training aids for EDP staff members. Users were notified of the change, the reasons for it, and of the basic pattern of the conversion. They were also involved in basic decisions concerning priority scheduling of applications and programming revisions. Because FORTRAN had been a standard programming language for some time, there was little difficulty in automatically translating those programs selected for that approach. Computer time for translations, debugging, and testing was particularly favorable, accounting for much of the success enjoyed. A special feature of the conversion was a worksheet for each program. The worksheet was a basic control device and contained vital information on start and completion dates, computer time, special problems, and general comments.

Another conversion case involved a large scale second to third generation change of both scientific and commercial operations.[26] The emphasis was on the applications aspects of conversion. Much of the conversion activity had yet to be completed at the time the presentation was written. The particular organization pattern established for conversion

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[26]Cartledge, "Program and File Conversion."

was discussed. The activities undertaken to schedule and establish priorities were presented. The early programming and testing activities occurred concurrently with the development of standards and ground rules. Program conversion approaches were established for programs not to be operated under emulation. Parts of the conversion plan were continuously developing and various changes were being made as the work continued. Although actual case information was brief, it was preceded by a thorough discussion of program and file conversion considerations and activities. The particular method of presentation, discussion, and identification of activities based on a specific case is very similar to that used for this study. A different level of conversion projects has been included for this study, which has been considerably broadened by using several conversion cases as the basis.

Summary of Literature

Literature reveals several specific area articles covering isolated topics of conversion and a few fairly comprehensive presentations of the conversion project. In the formal studies selected for the feasibility study which precedes conversion, a few individual cases appear. The cases, as did most of the other literature, considered only parts of the entire conversion project. They were designed to show only a particular conversion and appeared individually. The literature indicated a lack of definitive research dealing with conversion; therefore exploratory, basic research is appropriate.

This study was designed to provide a more comprehensive approach to the conversion project, based on a number of actual cases. It is intended to add essential breadth and depth to the existing body of

literature, based on formal research. The aspect of research will also provide a basis for further studies concerning the computer conversion project.

CHAPTER III

CONVERSION AND THE COMPUTER SYSTEM

In conversion from one computer to another the first order of commitment is to the machine itself. Without knowledge of the new computer system, there is no basis for positive action directed to the many other facets of the conversion project. Many supporting decisions must be based on the new computer system.

With third generation computers and the development of the software industry during the last half of the 1960's, increasing attention has been given to two aspects of the computer system: hardware and internal software. Until that time the equipment manufacturer was the only source for internal software, and the options offered were limited. Indeed it is difficult, at times, to isolate these features; new advances indicate software in the form of micro-coding is replacing previously designated hardware, or circuitry, functions. Nonetheless, physical equipment and internal systems considerations must be given to the new computer system. Once selected, the computer system's features guide much of the conversion.

Hardware Phases of Conversion

Various devices, mainframe and peripheral, are combined to achieve a specific computer configuration. The modularity of System/360 has allowed the user considerable flexibility in selecting a configuration to

meet particular needs. Once the configuration is known, preparations to house the new equipment can begin. Obviously the work must be completed when the computer arrives; therefore any work necessary must be completed between the time the order is placed and the delivery date.

Configuration Considerations

On the surface, conversion would appear to imply replacing one computer system with another. The physical picture begins with the existing computer, involves the old and the new for a time, and ends up with the new. While basically true, the situation presented is too simple. Some users do not intend to replace all their old equipment; some never get around to getting rid of the old. Others add new devices so quickly that they are never quite sure what the "new" equipment is.

Certainly the decision to keep or release a particular machine depends somewhat on whether it is owned or leased. Those with equipment leased from IBM were provided a month's changeover time on the old equipment after the new was installed. Under the arrangement, it was not disadvantageous to retain the machine during that period. The majority of the firms interviewed did, in fact, release their second generation equipment within the first month after installation of the 360. The others who released their old equipment, did so well after the first month.[1] Basically the firms ran into debugging difficulties that extended the usefulness of the old equipment. One firm had planned a four-month test period with equipment overlap regardless.[2] Another firm which planned to sell its old equipment has retained it indefinitely, after

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[1] Appendix II: Cases 5, 17.

[2] Ibid.: Case 17.

building a large inventory of new applications before transferring operation of the old programs to the new equipment.[3] Other firms which retained their old equipment intended to do so.[4]

Conversion cannot merely imply equipment replacement. In various circumstances the intent may be to keep the old equipment even though some operations on it are changed over to the new. The entire equipment configuration to be used must be considered in plans for the facilities and the ultimate operations.

It is not uncommon to find firms with second generation computer equipment also having unit record equipment, i.e., strictly punched card processing equipment. A good deal of the machinery may be idle the majority of the time. One company took advantage of the conversion situation to re-evaluate the use of all its EDP equipment, and eliminated a number of machines in addition to its second generation computer.[5]

System/360's modular design was intended to enable users to grow and change by adding individual units to a basic configuration. New devices and capabilities were announced periodically after the earliest systems were delivered. The only situation investigated which still has its original 360 configuration, is the one which is more or less locked into the configuration through a lease-purchase agreement.[6] The other extreme is illustrated by two cases, noting that at least some of the change is attributable to unexpected and rapid company growth or expanding data

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[3] Ibid.: Case 9.

[4] Ibid.: Cases 2, 16, 22.

[5] Ibid.: Case 20.

[6] Ibid.: Case 8.

processing services. In three years one company moved from a minimum configuration Model 40 to the maximum core capacity, additional and faster peripheral devices, and a different operating system. The firm placed an order for System/370 as soon as it was announced.[7] The other example situation expanded from a medium scale Model 30 to several System/360's, including two considerably larger than a Mod 30, in a little more than two years. On the other hand, some of the change in configuration has been by design. Five of the firms placed a series of orders at one time, with successive deliveries dependent on progress with previous equipment and its intended use.[8] The difficulty with such long range orders is that they must be updated as the picture changes: for instance, one company had to return an entire computer system upon discovering that there was no need for that computer's power and time.[9]

Thought must also be given to any changes in supporting equipment and related supplies. Additional or new key punches may have been ordered. It may be necessary to have a new form of magnetic tape, in greater quantities, and a number of disk packs may be needed. Space allocation and preparations will have to include consideration of side effects of the main computer configuration. It goes without saying that supporting equipment and supplies must be compatible with the new computer system, but some have learned this through trial and error.

Suggested Site Preparation Considerations

Before looking at what was actually done in relation to site preparation, it will be helpful to investigate suggested steps related to

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[7] Ibid.: Case 16.

[8] Ibid.: Cases 1, 2, 9, 12, 16, 19.

[9] Ibid.: Case 9.

physical installation of the computer. General guidelines and specific help from the manufacturer are available to aid users in preparing for and executing the site preparation phase of the conversion.

Site Preparation Suggestions

General Guidelines. Various checklists and approaches have been developed and published to assist users during the site preparation phase. According to Donald L. Adams, the advantage of such a checklist is in its design "to minimize the number of critical situations that arise during installation."[10] Adams' list includes detailed factors in six main areas: site areas, location and layout, site preparation, emergency facilities, support equipment, furniture and fixtures, and supplies and miscellaneous. Interestingly, the conversions investigated show that the last three were of minimal importance, and the location was limited primarily by the existing facilities or by available space within the firm's building. Layout factors and physical adaptations necessary to operate the new equipment were the main concern.

In a conversion situation, computer site plans cannot be limited to the new computer alone. Frequently the existing equipment will be kept and used for some overlapping period. Additional floor space may be required for the transition period. In this respect many users were fortunate to find that their 1401 equipment would run almost anywhere, including the hall next to the computer room. Facts concerning floor space, power and general environment throughout, support equipment, and the flow

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[10]Donald L. Adams, "Planning Check List for a Computer Installation," Datamation, June, 1967, p. 37.

of operations must all be taken into consideration for the existing computer, the transition situation, and the ultimate new configuration.[11] Two dates become important: the delivery date of the new equipment and the release date for the old equipment.

Manufacturer Assistance. IBM provided direct assistance to users converting to System/360 through its Customer Engineers and the Facilities Guide. Both provided information concerning layout and environment specifications. The Facilities Guide is a manual which sets out space, electrical, and other requirments for all 360 equipment. An I.B.M. Customer Engineer, called a "C.E.," was required to approve site plans and was available as a consultant during the preparation of the plans. These two sources, more than any other, indicate what needs to be done. However, work elements required, work assignments, and the time schedule followed are up to the data processing manager or the person he designates to be in charge.

Actual Site Preparations

In reality, site preparation rests on the results of negotiations with management and the C.E. Management has the final say, but cannot argue with bare essentials like adequate wiring, air conditioning, and humidity. The Customer Engineer may help develop an ideal plan, and, at the same time, cannot accept less than minimum requirements or the equipment will not function. The most prominent area over which the company's management has control is floor space allocation and other extras associated with floor space.

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[11] E. J. Helman, "The Facilities Approach to System Conversion," Data Processing Magazine, October, 1966, p. 37.

Computer Room Necessities. An ideal situation would be construction of a totally new facility, if only to keep out of the way of the existing data processing activities, with an eye to future expansion. A majority of the firms interviewed had to make do with existing space or with slightly expanded space in the same location. The transition phase, when two computers are in operation in the original space, provides numerous layout headaches. The intermediate and ultimate layouts and environment specifications require a good deal of foresight. All users relied heavily on the help and ultimate approval of the Customer Engineers in the difficult space re-allocation situations. Very few were fortunate enough to have the existing environment conditions meet 360 specifications. When the same computer room is to be used for both, timing is particularly critical; operations cannot be stopped for three or four months to finish the physical work.

Of those users who were able to build new computer facilities, a few indicated that it was a timely situation with their firms in the preparation stages of general building programs at the time the computer orders were placed. In situations where a new computer facility had to be constructed, the C.E.'s were frequently allowed to work directly with the building and maintenance staff, or even the architect for the project.[12] Basically, the new computer rooms were planned and constructed for the hardware which was ordered, and allowed for "reasonable" expansion. The modular construction design of the 360 provides for relatively simple expansion and addition of physical units to the basic computer. Computer systems have been built up faster and larger than had been foreseen by

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[12]Appendix II: Cases 10, 21, 27.

those providing new computer rooms. Equipment crowding has become common.

The Extras. Conversion presented a convenient time to make a number of changes throughout the data processing area; physical space was no exception. At one extreme were those who ended up with completely new computer centers: office space, computer room, storage facilities, and even a special systems design or Customer Engineer's office.[13] Some of the less extravagant did take the opportunity to do renovation work on an existing computer room, with glass viewing areas or new paint. Note that none of these activities were directly related to installing the new equipment, but they were planned and carried out in connection with the general construction required.

Post-Conversion Observations. Since installation of the initial configuration, most companies have altered their configurations drastically and rapidly. Although a few installations have been moved to completely new buildings, the majority have become overcrowded. It is interesting to note the safety consciousness in regard to recent new facilities.[14] The first few floors of a building are avoided, since the ease of equipment movement they provide is of lesser importance. Special records storage locations are included. Inside locations for computer rooms and storage areas are preferred.

Software Phases of Conversion

The software portion of a computer system goes hand-in-hand with the physical components. It serves as a link between the user's

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[13] Ibid.: Cases 4, 10, 11, 17, 23, 26, 27.

[14] Ibid.: Case 6.

applications and the computer hardware. The degree and type of work required in relation to the system's software was new. Users of second generation equipment had not previously experienced such work. A greater software consciousness has eventually evolved. Selection of specific elements of the software package shaped the early operating environment. To understand the basic decisions which were made, the software situation must be described. Work resulting from software decisions can then be discussed meaningfully.

Emerging Software Consciousness

Until the third generation, the only necessary basis for evaluating a computer was in terms of hardware features: how fast it read cards, tape, or disks; how fast it accessed core data; how many calculations it made per minute. Because users knew how to handle hardware-based features, they concentrated on them in developing their third generation computer systems. Yet the computers offered much more than electrosonic speed.

> A major and increasing important part of the planning for the installation of a new computer must be devoted to the examination of available software and the selection of the components that will most nearly fill the needs of the installation.[15]

The importance came about after the fact for those who converted early in the game. While these users could relate to increased core and speed offered by the new hardware, they did not totally comprehend the software.

> The transition to third generation had unfortunate effects on computer users: Users were not prepared for the increased cost and complexities of the new software.[16]

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[15]"Economic Considerations of Conversion," Datamation, January, 1966. p. 33.

[16]Enger, "Putting MIS to Work," p. 21.

The fact is that only three of the conversions investigated were undertaken because of software-based factors: two intended to include tele-processing and communications features in their applications from the outset; the other was interested in the total picture concerning the computer system and the direction of the company's applications.[17] The majority of the remaining cases were concerned with speed and increased core. Preoccupation with the hardware characteristics ultimately lead to later difficulties and changes of approach.

Not all the blame can be directed to the users, as the software packages for the computers were not completed when the system was announced. The hardware was functional well before the software was. Actually, it becomes difficult to tell just when the software is complete. Minor changes are accepted as a fact of life after receiving continuous updates of a software package. For example:

> With some software packages, the supplier (today, usually the computer manufacturer) is continually releasing improved versions of each package. It is not unusual, for instance, for program translators to have had twenty or thirty versions--and the user is expected to be using the most recent version.[18]

Major changes to a given segment of the package appear less frequently, yet probably result in more total impact. The evolution of the compatibility package allowing 1400 series programs to run on the 360 is a case in point. When originally released, the package provided an operation exactly like that of the old equipment, a one-job-at-a-time situation requiring manual intervention to bring in the package. In

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[17] Appendix II: Cases 2, 22, 28.

[18] Canning and Sission, The Management of Data Processing, p. 88.

1967, a major revision eliminated the need for manual intervention each time there was a change from a native mode operating system to the compatibility package, and the job stream concept became possible. A third major change in 1970 provided capabilities to run compatibility jobs under the multi-programming concept. A vastly improved package has resulted, but in the process users can never be quite sure what their operating environment will be.

Uncertainty and continuous updating related to a vitally impor- that part of the computer system, perhaps more than anything else, has brought about software consciousness. The entrance of software houses into the area of internal software increases the options available once the computer has been on the market for a time. For new computing systems, however, the manufacturer will continue to be the only source of hardware and software components.

Basic Software Decisions

Very simply, the decisions a user faces are for the basic package, or the operating system, and the language translators within that package. The one other factor involved is whether or not to use a compatibility package when an applicable one is available.

Operating System. An operating system essentially consists of programs which prepare and execute the user's programs, or applications. Included in such a package are various programs designed to control the data, the applications and even parts of the operating system itself, number of utilities, services, and programming language capabilities.

System/360 provided four different operating systems with varying degrees of flexibility, sophistication, and options. These operating

systems go by the acronyms BOS, TOS, DOS, and OS for Basic, Tape, Disk, and the full Operating System. Ideally, the operating system to be used is selected in relation to the hardware configuration and the applications to be run on the system. The hardware determines the level of the operating system to the extent of required devices and core storage. All but TOS require disk residence. As might be expected, the more comprehensive the operating system, the more core storage it will require and eliminate from use by the applications programs.[19] Similarly, the more sophisticated applications require the facilities of the more sophisticated operating systems. A tele-processing application, for instance, required the facilities provided by either DOS or OS. The operating system, in turn, may limit the programming language choices.

Programming Languages. The programming language capabilities available, like the rest of the operating system capabilities, are up to the manufacturer. Department of Defense requirements and scientific programming convention do influence the presence of COBOL and FORTRAN on the list. As usual, a single low level language is provided for those desiring the increased flexibility or the core-saving features such a language provides. With System/360 users can choose among Assembler, the low-level language; and RPG, COBOL, FORTRAN, and PL/1, the high-level languages. The condition is that users selecting the Basic Operating System are limited to Assembler and RPG. A user could choose to use all the languages applicable under the operating system, remembering that the processing program required will take additional core space.

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[19]This is not necessarily a concern in relation to operating systems with other manufacturers' third generation computers. For instance, the complete operating system for the Burrough's 2500, takes only a minimal amount of core.

A brief look at the advantages and disadvantages offered by each will indicate the trade-off features to be considered. As mentioned, Assembler is the most flexible and requires the least amount of core for its translator program and for applications written in the language. It is, however, more difficult to learn than are the high-level languages. RPG is another IBM capability designed especially for reporting operations and one that prepares reports from input data and format descriptions. There is no real logic capability provided through the use of RPG. COBOL and FORTRAN are programming languages supported by all manufacturers and are considerably more flexible than RPG. COBOL was designed specifically for commercial applications and FORTRAN for scientific programming problems, although they are not limited to the intended area of use. PL/1 is an IBM language released well after the first System/360's were in use. The language was designed to take advantage of the pluses from FORTRAN and COBOL.

One astute investigation into the programming language decision summarizes the situation:

> In selecting a language, all but the very largest data processing installations are restricted to the compilers offered by the manufacturers and a few proprietary software vendors. If program mobility is an important consideration, you should look askance at any languages which are not being supported by all manufacturers of the general class of computers in which you are interested.[20]

The general limitation to languages offered by the manufacturer, and common inclusion of COBOL and FORTRAN by all manufacturers, given a class of equipment, have been stressed.

Compatibility Feature. In addition to the operating system, a

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[20]Raymond J. Rubey, "COBOL,PL/1, or What?" Data Processing Digest, August, 1968, p. 1.

user could get a compatibility package which would enable System/360 to read programs written for other IBM computers and function like that system. The compatibility feature, also called an emulator, was available for certain second generation machines run on certain Models of the System/360. Both Models 30 and 40 provided compatibility features for the 1401 and the 1460; but the 1410 emulation was possible only on a Model 40, and 1440 on a 30. Therefore, if the compatibility feature was to be obtained, the old equipment placed some limit on the particular configuration of the new system.

The compatibility feature is a combination of hardware and software allowing one computer to imitate another. Because circuitry is included, it is possible to run the old jobs faster than if a software package, called a simulator, is used. Most users were able to process their old programs faster on a 360 with a compatibility feature than they had been able to process them on the old equipment.

Since the first package was available, with the earliest 360's delivered, two major improvements have considerably improved the operating environment.[21] Although each main version was known by a different name, the compatibility feature will be referred to through this study as COS or the Compatibility Operating System, the second of the three main releases.

Compatibility features allow users to move their old programs to the new computer with a minimal amount of effort. This can act as an aid to the total conversion effort, or may be the applications conversion method employed. These aspects of emulation are discussed more fully in Chapter IV, Conversion and Applications.

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[21]Previously discussed on Pages 47-48.

Decisions and Results. Keeping the software options in mind, it will be easier to see what the users decided and what resulted from the decisions made. Required changes from the original decision are particularly critical to the over-all picture of conversion. Non-standard usages have complicated the use of the compatibility package.

Operating System. The operating system selection, as mentioned, influences the entire data processing operation from system design through operation. An appropriate initial decision then is essential to a smooth and lasting conversion. The only real problems observed were related to two decisions to use TOS.[22] Any system located on tape runs considerably slower than one on a direct access device like a disk. In these cases no disk peripherals had been ordered, and TOS was the only choice. Within a year, each found that the hoped-for speed factor was not possible when System/360 was limited to the tape situation. When the problem was corrected by changing to DOS, the data processing managers felt most of the progress during the first year had been wiped out. While a bit difficult to measure, in these cases the original decision delayed completion of conversion by a year. The other users investigated either maintained their original system or changed well after the initial use period.

Languages. Essentially the same can be said for language decisions as for operating system decisions. It did not really matter what the decision was as long as it was adequate for the projects in mind. The two companies which chose RPG as their only programming language were forced to change within the first year after installation of their System/360's.[23] Most of the system design work and all the programming

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[22]Appendix II: Cases 8, 25.

[23]Ibid.: Cases 8, 27.

had to be discarded when testing phases indicated the language was inadequate for the tasks at hand. The programmers had to learn a second new language and re-experience the practical part of learning how the language functions on the computer. The systems design was re-done from a computer system point of view. The new applications essentially went through a period of halt and restart, again losing the first year's efforts on the new computer and most of the time devoted to the project before the equipment arrived. The second time, however, the design and programming work did take advantage of mistakes made during the first undertaking.

The other situations investigated chose FORTRAN (one), Assembler, or COBOL, or a combination of the last two. Although the FORTRAN decision was rescinded, more than two years after installation of the System/360, it did not force a halt in development procedures. For the remainder, only changes in emphasis have occurred with no effect on the applications implemented in either language.

Compatibility Feature. The only firms which did not order the compatibility feature with their System/360's were those which installed totally new applications based on tele-processing at the same time they installed their equipment.[24] Of those remaining, a number gave a great deal of special attention to the compatibility feature before transferring operations to the new equipment.[25] Some users found they required modifications in the package, their programs, or both. One company spent considerable time adapting the system to handle a special labeling process, or technique, used on its extensive set of 1401 tapes.[26] Another directed

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[24] Ibid.: Cases 24, 28.

[25] Ibid.: Cases 3, 4, 7, 9, 11, 12, 14, 17, 20.

[26] Ibid.: Case 9.

the majority of its pre-installation lead time and test time to modifying the compatibility feature so their random access files could be processed accurately.[27] A further example of modification work is shown by the company which required parts of three different versions of the compatibility package in order to meet its requirements.[28] The modifications involve highly technical work which is time-consuming and even exploratory. The requirement for modification work occurred in 1966 installations as well as in those of 1969, indicating that it was not just an oversight in the early releases of the compatibility features. The more non-standard applications and second generation configuration, however, made the modifications necessary. The users with a standard configuration who had used the programming language with a few special techniques found little need to be highly concerned with perfecting and testing the compatibility feature; they quickly shifted operations. It is important to note here that those with "non-standard" situations are not incorrect if they are out of line. Frequently it is much more efficient from a processing and utilization standpoint to be "non-standard."

Other Computer System Considerations

Data Base. The device and software features have already been discussed, but probably more than any other single element, the new basic form of storing and recording data contributed to the non-compatibility of third generation with the second has been stressed. The computer system's form of data representation is highly related to both hardware and

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[27] Ibid.: Case 17.

[28] Ibid.: Case 20.

software. It is of special concern when the data base between two machines is different. The way characters are represented internally, or different character sets, can affect expected sequences, specially designed coding tests, and the like. When a change in data base occurs, extra care must be taken in converting files and programs to assure that the change has been properly accounted for. A simple example illustrates alteration of the collating sequence:[29] With the old computers, the highest possible value was represented by 9's; therefore to make sure an item came at the end of a sequence, it would be set to 9's. For System/360 there are a number of values higher than 9 meaning that an item of 9's would not necessarily come at the end of a sorted sequence.

One other change in the way in which data was represented was the size of the computer's basic unit called a "word." The word size was of particular concern to scientific data processing functions using FORTRAN.

Supported Systems. Manufacturer support of systems is an important element in the total picture of a computer system. A supported system is one which is maintained by the manufacturer. While in the IBM framework there are different levels of support, the thing to keep in mind is that it is risky for most users to have unsupported systems; they are not likely to have the technical skills available to maintain the system. The idea of supported and non-supported systems is of particular significance in relation to software releases. Between the first System/360 deliveries and June 1970, twenty-three versions of the operating system had been announced. It is practical for IBM to support only the most recent releases. Those users not updating their operating system version along with the

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[29] Ibid.: Case 9.

releases may have difficulty obtaining information and help with the exact version in use.

The role unbundling will play in future views of support is still uncertain. "Unbundling" refers to the pricing policy IBM announced in 1969 separating hardware and software charges. The immediate reaction was that users would be unwilling to buy software help. Support was frequently sited as a main reason for converting to third generation by those investigated for this study. The one firm surveyed which placed an immediate order for System/370 also sited support as a main reason for changing again.

Summary

The specific hardware and software components of a computer set the scene for other phases of the conversion project. Their founding role will become even more apparent in the next three chapters. A part of the work done in the total conversion effort is directly related to the new computer system itself. Site preparation activities include layout design and construction to meet the specifications of the hardware elements to be installed. New locations or additional space are limited by managerial decision. The hardware configurations changed and expanded quickly after the initial installation and before completion of the conversion project. Some of these changes were by design, but more frequently they were not. Over-crowded computer facilities have resulted in most cases. Software decisions became noticeably critical in situations where inadequate operating systems and programming languages were put to work and changed in mid-stream to correct the error. Years of work were lost in these situations. Those users also electing to use the compatibility feature and not possessing fairly standard second generation usages found themselves devoting a good deal of time to modifying the package.

CHAPTER IV

CONVERSION AND APPLICATIONS

Unquestionably, the first thing which comes to mind at the mention of "computer conversions" is the change-over of current applications. The bulk of the literature related to conversion is devoted to in-house programs and files.[1] Users investigated for this study mentioned applications-oriented aspects first and foremost. The firm's applications certainly are at the crux of any conversion project.

Programs, files, and standards are the facilitating elements of a company's applications library. Possible conversion approaches for programs and files, the way users carried out the approaches, and the outcomes are discussed in this chapter. The role documentation plays is also presented. Testing and actual implementation, the last two steps in applications conversions, are likewise illustrated.

Program Conversion

There are a number of different approaches which can be used in changing applications from one computer to another. It is necessary to know what these approaches are and to have a feeling for their strong and weak points in order to understand what the users actually did.

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[1]The most comprehensive sources include: Canning, "Conversion;" Cartledge, "Program and File Conversion," pp. 22-27; Kahn and Fuller, "Program Conversion," pp. 28-31.

Alternative Approaches

The approach chosen may apply to a single program, some group of programs, or to the entire library. It is likely that some mix of approaches will be used. The possible program conversion methods are presented in the order of relative ease of completion: recompilation, emulation, translation, rewrite, and redesign. The redesign approach may be so comprehensive that it results in an almost new application. Extensively redesigned and new applications do not represent program conversions per se, but they are included since they are often part of the original objectives of the total conversion.

Recompilation. The recompilation approach to program conversion is theoretically possible when a program is written in a language that is machine independent, like FORTRAN or COBOL. The source deck for the program is merely processed by the new compiler and readied for execution on the new machine. Recompilation is not necessarily as simple as it sounds, because no language is wholly machine independent.

> While a programming language, by design, can be relatively independent of any specified computer, the processor with which this language is translated into a specific machine language must, by its very nature, be machine dependent.[2]

If the subtleties are not taken into account, the recompiled program will not be like the one originally compiled. Some problems can be avoided by using the language in a standard way. The users who had 1410 equipment and chose to write programs in COBOL were able to use the recompile approach.

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[2]Robert Silverstone, "Recompilation," Data Processing Magazine, September, 1966, p. 28. The article also lists steps which can be taken to make recompilation successful.

Emulation. The compatibility features mentioned in Chapter II allow emulation, or execution of programs written for another computer. Emulation may be used either as an intermediary step in applications conversion or as the final step in the process. Some authorities, however, question using emulation as the final approach in the long run:

> As a long-range approach, however, emulation or simulation can only hinder the installation by the burdens and difficulties imposed upon the computer operations department, by the growing lack of programmers familiar with out dated languages, by the machine inefficiency if multiprogramming is not available, and by the tendency toward usage as a permanent crutch.[3]

The limit to either transitional or permanent use of emulation is that it will only work within certain restrictions on devices or on programs written strictly according to published manuals and standard procedures for the old machine. Program adaptation or modification of the compatibility package may be required before the emulation approach can be effectively used.

Simulation features were also available for some features of second generation equipment. Because it is a means of achieving compatibility entirely based on software, simulation is considerably slower than emulation. Two of the users in this study used simulation features as intermediate steps toward applications conversion.[4] The firms also used emulation capabilities. Simulation and emulation approaches will be considered together as emulation due to their similar purposes.

Translation. There are two types of program translation: automatic and manual. Automatic translation is done with the aid of a computer, while manual translation is recoding done by man.

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[3]Kahn and Fuller, "Program Conversion," p. 30.

[4]Appendix II: Cases 22, 23.

Automatic. A language translation program known as a translator or a liberator directs the automatic translation. The goal of the programs is to produce a source program deck in the new language after reading and processing the old. Automatic translation, as in spoken language translation, gets most of the job done, but problems occur with idioms, slang, or peculiarities. Just as it is impossible to translate the English word "put" into German, it is also impossible to translate computer languages, word for word. The translator flags many of the difficulties for manual correction, but

> real debugging problems can arise when an error is made in translation, because the programmer will be working with the old program, the new program, and the translator program.[5]

ACAP[6] and EXODUS II[7] are translators designed for Autocoder to COBOL or Basic Assembly Language and are applicable to the cases represented in this study. One estimate indicates that unless the translation accurately gets 80 to 98 per cent of the source coding, the programming work involved becomes as great as the manual recoding approach.[8] While no one represented in this survey tried the EXODUS translator, others have, with varying degrees of success.

> A limited survey indicates that while EXODUS does achieve a translation of Autocoder of somewhat over 75% (CSC claims 80% to 95%), it does not handle disc I/O and the remainder were difficult changes. One of the drawbacks is that you have to learn the EXODUS "language"....[9]

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[5]Canning, "Conversion," p. 5.

[6]ACAP was available to aid with the earliest program conversions through IBM.

[7]EXODUS II, developed at Boise Cascade, is available through Computer Sciences Corporation.

[8]Kahn and Fuller, "Program Conversion," p. 29.

[9]Henry A. Lechstein, "When Should You Emulate?" Datamation, November, 1969, p. 210.

Similar difficulties arise with the use of ACAP. A number of the users interviewed tried to use the translator and gave up after a very few programs. Only one found it particularly useful, and that was in connection with rapid conversion of a very large number of small programs written fairly simply.[10]

Recode. Manual translation, or recoding, eliminates some of the disadvantages of automatic translation. The programmer is more likely to pick out the coding tricks and to allow for device or language differences in the process than is the automatic translator. The new program will use the same input, the same logic, and will produce the same output as the old. The approach may be complicated when a program has been repeatedly patched, when little or poor documentation exists, or when the original programmer is no longer available.

Rewrite. The difference between recoding and rewriting or rewriting and redesigning is primarily one of degree. Aspects of recode and redesign are involved in rewriting. The redesign which occurs is programming-oriented, and is mainly concerned with logic alterations, taking into account efficiency measures for the language and new equipment. The program, in general, can be cleaned up and can eliminate patchwork required for program maintenance, as in the recode approach.

Redesign. The redesign approach is the most comprehensive and time-consuming of the applications conversion methods. Redesign implies redoing a system or group of systems from the analysis stage through implementation. Correctly done, redesign would provide improved applications from the user's point of view and from the standpoint of computer

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[10]Appendix II: Case 28.

efficiency. The different types of redesign possible are outlined by Canning and Sission:

1. Conversion of an established, well defined application such as accounts receivable or payroll.
2. Consolidation of several existing applications to form a more integrated system, such as the consolidation of inventory control, within a production control system.
3. Development of a common data file to support a number of applications and to provide consistent data for a management information system.
4. Development of a system to provide significantly improved performance in a major on-going segment of the enterprise for both information processing and the related physical or service operations....[11]

The range of redesign is considerable, going from necessary improvement to a totally new approach which may affect the whole company at one time. The advantage of redesign is in improvements in machine efficiency and in new capabilities applied to reassessed company needs. A danger exists in "attempting to plan a system that was too sophisticated for its (the company's) limited EDP specialists."[12] Furthermore, there may be no company need for a system that is "too" sophisticated.

New Systems. The more comprehensive types of redesign probably include new systems. While systems which have not existed cannot be converted, many new computers were obtained for the purpose of implementing certain new systems. Intended new systems, therefore, are considered part of the total conversion picture, in that initial objectives for the computer are not met until these new systems are operational.

Which Approach. Kahn and Fuller suggest a way of determining which approach to use by comparing the permanency of the proposed method

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[11]Canning and Sission, Management of Data Processing, pp. 6-7.

[12]George E. Delehanty, "Organization Structure in Insurance Firms," in Charles A. Myers' The Impact of Computers on Management, (Cambridge, Massachusetts: The M. I. T. Press, 1967), p. 83.

with the effort involved with longevity, proportional to the effort and resources expended. If a system is expected to be operational for eight years or more, redesign is appropriate; five to eight years, rewrite; one to two years, manual or automatic translation; six months to one year, simulation or emulation.[13] The methods can be mixed according to the needs of the systems involved and the objectives of the total conversion.

Regardless of the approach selected for a program, a system, or the entire library, some check out, and testing will be required. If the approach leaves the old program essentially unchanged, the new version must match the old as far as results are concerned. As the number and complexity of the changes increases, debug and testing become relatively more difficult and time consuming.

User Applications Conversions

Knowing what paths have been open, it will now be easier to investigate what the users did for the applications phase of the conversion. The analysis requires an array of information concerning the objectives of the conversion project, the intended approach, the real action taken, and the results. It would be fruitless to view the steps actually followed during the applications conversion alone; other factors provide insight essential to the process.

Conversion Objectives. The study of the commercial firms' conversions indicated that hardware related objectives were the most common and most pressing. Users were interested in faster throughput and processing times and increased core storage capacities far more than any

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[13]Kahn and Fuller, "Program Conversion," p. 31.

other features of the new computer system. Over half of the users indicated only the speed and storage factors as influencing their decision to convert. Another third emphasized speed and storage and included the opportunity to add much needed new applications. The remaining users cited software related objectives: the new equipment allowed them to meet processing and organizational requirements. Three firms required teleprocessing capabilities to unite the data processing efforts of well separated sub-firms.[14] Another three users wanted to get all their data processing operations on one computer.[15] The last three firms' conversion objectives were based on company-wide recognition of better computer utilization possibilities to meet their particular needs.[16] The essential objectives, then, break down into three main categories: hardware related; hardware and new applications; software and new applications.

The conversion objectives indicate the approaches which might be expected. In most circumstances, compatibility features provided faster run times than the second generation equipment, so it is reasonable that many firms concerned with speed and storage would use emulation, translation, or recoding. The users whose objectives were more software related would be inclined toward rewrite and redesign.

Planned Approaches. It would seem reasonable to look at the conversion approaches which the firms planned to use in relation to their configuration selections and conversion objectives. The configuration selections indicated that all but one user planned to rely on compatibility to some degree. Knowledge of the intended use of emulation does not

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[14] Appendix II: Cases 10, 24, 28.

[15] Ibid.: Cases 7, 13, 20.

[16] Ibid.: Cases 2, 22, 23.

provide an adequate basis for investigating the plans. Therefore, the conversion objectives may serve as a more informative base from which to investigate the planned conversion approaches.

Of those users with hardware-oriented objectives, all planned to run a good number of their old programs under emulation either as an interim step or as a permanent measure. All the firms using emulation as an intermediate step planned to redesign, rewrite or recode all the programs and eliminate reliance on the compatibility feature.[17] By using emulation as an interim step, the users felt they would be better prepared to change the systems to native mode operation after in-house experience with the computer. Four of the firms planned only to emulate their applications.[18] In other words, all their applications were considered converted when they were running under the compatibility features. The other firms whose prime objective was related to hardware features of the new equipment planned to emulate either a major system or a fair share of their libraries on a permanent basis. The rest of their applications were expected to change through recoding, rewriting, or redesigning.[19]

A significant difference between the users with hardware based conversion objectives and those with combined hardware applications-based objectives is in the importance of new applications. Most of the users with hardware objectives ultimately became concerned with getting the new applications on the computer in a native mode situation. The hardware-applications group felt that the new or greatly redesigned

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[17] Ibid.: Cases 1, 3, 6, 11, 17, 27.

[18] Ibid.: Cases 5, 12, 14, 21.

[19] Ibid.: Cases 4, 16, 26.

applications helped justify the new computer system. They were unable to get many applications done with the old computer system. Considerable attention was given to the development of the new native mode systems by these users. The old systems were divided among the same approaches as used by the firms with only hardware-related objectives: emulate all old applications; emulate some and rework the rest for native mode; emulate as an intermediate step only.

The third major conversion objective placed importance on the software capabilities of the new computer system. The capabilities were viewed in relation to the firms' applications. The firms also recognized that faster hardware features were a part of the whole picture. Four firms saw a major change of approach for their data processing environment. One redesigned its entire library of applications, integrating the programs and changing the supporting data base.[20] Another firm put in a central computer to eliminate various first and second generation machines held by subordinate firms. The subordinates would process their work by teleprocessing links.[21] These concepts meant that the new system had to be implemented all at once, rather than one segment at a time. The other two firms which changed their data processing approach were able to implement portions of the new system separately.[22] Emulation was used to bridge the gap while the various segments were completed. These firms found special care had to be taken to make sure data interfaces were consistent when both new and old systems were still operating.

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[20] Ibid.: Case 24.

[21] Ibid.: Case 28.

[22] Ibid.: Case 2, 10.

The approaches employed by the users can be grouped into four categories. Three categories apply to the use of emulation: complete emulation of all old programs, continued emulation of some programs with others converted to native mode operations, and intermediate emulation enabling gradual movement to totally native mode operations. Programs written and compiled on the new computer system will operate in native mode. The fourth category applies to new or redesigned applications, when they were considered as part of the conversion objectives.

Actual Approaches. The time span of the total conversion project is usually considerable. Thus there is a good chance the approach will be changed from the one planned. Over half of the users contacted for this study, however, did not noticeably alter their planned approach. Many took longer than anticipated, but the applications were still handled in the planned manner. One firm continued with the initial plan, but expanded the objectives of the conversion project shortly after the new computer was installed.[23] The firm had ordered two computers with staggered installation dates. Mechanical difficulties with the first led to eliminating it and getting the second earlier than scheduled. During the experience with the first, the capabilities of the new equipment became clearer, and considerably expanded applications were planned in addition to more extensive redesign for the old systems.

Table V summarizes the objectives and planned approaches of the users investigated in this study.

The applications conversion approaches of the remaining firms were changed either before installation of the new equipment or during

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[23] Ibid.: Case 1.

TABLE V

RELATIONSHIP OF OBJECTIVES AND APPROACHES PLANNED FOR APPLICATIONS CONVERSIONS

Basic Approaches Planned To Meet Objectives	Primary Objectives: Hardware Related Speed, Space	Primary Objectives: Combine Hardware-Applications	Combine Software Capabilities-Applications
Old Program Library:			
Emulate all continuously	14%	11%	4%
Emulate some continuously, Recode, Rewrite or Redesign remaining	11%	11%	
Emulate as intermediate step to rewrite or redesign	22%	18%	7%
New Programs as part of original new computer objectives	Not Applicable	39%	18%

post-installation conversion activity. Why the approaches were changed is as important as how; both factors will be discussed.

Four firms which changed approaches did so because they had made basic decisions inconsistent with their requirements. One firm chose an inadequate hardware mix, causing a change from tape to disk operations after considerable work on the applications had been implemented.[24] Two firms selected and started using programming languages which were inadequate for the tasks at nand. These firms experienced two redesigns of their systems as well as two sets of programming and check out work on most of the programs.[25] One benefit resulted: the second redesign provided

[24] Ibid.: Case 25.

[25] Ibid.: Cases 9, 27.

systems more consistent with the new computer system's capabilities. The last firm required to change its approach found emulation and teleprocessing to be imcompatible. A quick elimination of emulation jobs was made necessary because original recommendations citing the difficulties of running compatibility jobs in a T.P. environment had been rejected.[26]

Another group of firms found themselves changing their conversion approaches because of company-wide changes. Two companies announced mergers during conversion preparations.[27] A third company experienced a merger which actually caused the conversion to the new computer.[28] Although a conversion had been anticipated, the merger announcement forced it much sooner than intended. The firm's 360 was to be moved in to replace the parent firm's 1401 with only three months notice. A change of approach was also required by a firm which made formal arrangements to become a regional representative for a national service.[29] The firm was already handling the service on a similar basis locally. These company-wide announcements required that data processing priorities be redirected to include the new situation as soon as possible. The urgency of the activities meant that two conversions were taking place almost simultaneously: conversion to match the processing requirements of the organization and conversion to the new computer system.

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[26] Ibid.: Case 28.

[27] Ibid.: Cases 3, 17.

[28] Ibid.: Case 20.

[29] Ibid.: Case 5.

There are three other firms whose applications approaches were not executed as planned. Two of the firms became delayed with day-to-day program operations and maintenance and found several prospective systems on demand.[30] The day to day work and the developmental systems took precedence over the planned conversion sequence, repeatedly delaying completion of the task. The management of the remaining firm asked that the approach be changed from a combination of recoding and continued emulation to a comprehensive redesign which would ultimately eliminate the compatibility feature.

The general direction of the changed conversion approaches was toward more comprehensive use of the third generation computer system. In the process, all firms experienced more work and more steps than they had anticipated. Some were also under considerable pressure to get the job done quickly. New programs or responsibilities were a factor in all but the two changed approaches requiring second redesign efforts. Table VI shows the direction of the shift in importance from applications conversion as originally planned to that actually carried out.

Results and Evaluation. Longer term results pertaining to the conversion objectives and approach show the adequacy of the action taken for each firm's situation. A number of firms have completed the applications conversion, although others were still working toward completion at the time they were interviewed. Completion of applications conversion meant that the work implied by the approach was actually taken and finished. Action taken which reflected directly on the conversion approach since completing the process is an important indicator of the ultimate adequacy of that approach.

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[30] Ibid.: Cases 6, 11.

TABLE VI

RELATIONSHIP OF OBJECTIVES AND APPROACHES
TAKEN DURING APPLICATIONS CONVERSIONS

Basic Approaches Taken to Meet Objectives	Primary Objectives		Combine Software Capabilities-Applications
	Hardware Related Speed, Space	Combined Hardware Applications	
Old Program Library			
Emulate All Permanently	11%	11%	
Emulate Some Permanently Change Remaining	11%	14%	
Emulate as Intermediate Step Only	4%	28%	18%
New Program as Part of Revised New Computer Objectives	Not Applicable	54%	22%

Seven of the firms completing their conversions according to the objectives and approach taken have since moved to eliminate the use of the compatibility operating mode. This group includes only firms which chose to emulate all or some portion of their applications on a continuous basis. Some of the users in this group merely found their work load had returned to normal and that they had time to get all their applications running as native mode programs.[31] These users also felt it was becoming increasingly difficult to find people to maintain the old programs. Another firm designed a teleprocessing system to replace the major application it retained under emulation; once the new system becomes operational, the compatibility features will also be eliminated there.[32] The other two data processing

[31] Ibid.: Cases 4, 19, 21, 26.

[32] Ibid.: Case 16.

departments represented in this group were directed to eliminate compatibility mode operations by company management.[33] In fact, a new data processing manager was hired in one case for the express purpose of eliminating the emulation jobs streamlining operations in general.[34] The new manager is in the process of developing a conversion plan no different from one which could have been used when the new computer was originally brought in. These positive efforts to eliminate the use of the compatibility are significant. The other firms intending to emulate all or some portion of their applications were still doing so when contacted for this study. Two of these firms use adaptations of comprehensive, purchased applications packages, and indicate they will consider changing to third generation-based versions of the packages only when they are proven accurate.[35]

File Conversion

Conversion of a firm's data files is as important as the program phase of the applications conversion. The data formats and media must be compatible with the new computer before the programs can process the information accurately. There are a number of reasons for performing file conversion at some level in changing from second to third generation. These reasons will be examined before the users' file conversion experiences are explained.

Reasons

File conversion may be made necessary by a change in media, from

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[33] Ibid.: Cases 12, 14.

[34] Ibid.: Case 14.

[35] Ibid.: Cases 16, 20.

an efficiency standpoint, or to compensate for special differences between the old and new computers.

Media changes occur when data is stored or recorded on something new for use on the new computer. The basic storage media are cards, tape, and disk or mass storage. Two of the users investigated had used 1401-card systems, meaning their second generation data was recorded, transmitted and stored on punched cards.[36] Both firms chose to convert their card records to tape records for use on the new equipment. Tape processing gave faster processing times and greater data handling efficiency. Media changes also occurred for users going from seven-track to nine-track tape or from second generation to 360 disk storage. While tape to tape or disk to disk changes do not seem to be media changes, they are in the situation presented by conversion from second to third generation equipment. The old seven-track tapes cannot be read by the nine-track drives. Similarly, the old disk packs are not interchangeable with the new.

The direction of media changes by the users was never to slower types. As mentioned, some users changed to tape from cards; others moved to disk from tape, to tape from tape, or to disk from disk. For the most part, the media changes provide increased processing efficiency.

Further efficiency improvements are possible by taking special third generation characteristics into account for file conversion efforts. The format of data and file organization provide examples of efficiency measures. Numerical data can be represented in three different ways on tape and disk for System 360. One of the numerical forms, packed decimal, requires less space and allows for the most efficient processing when the

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[36] Ibid.: Cases 23, 25.

number is used in computation. W. J. Carteledge, Jr., correctly points out that users who do not convert their computational numbers

> will be paying for conversion continuously on System/360, since a "computational" usage of any input data, like amount fields, will require internal conversion from zoned decimal to packed decimal, and back again for output.[37]

The user will have to decide which is most important: a format giving the least number of processing conversions or one allowing space-saving features. File organization and placement is of particular importance in dealing with disk storage. The proper arrangement of the file will give most efficient access to data when needed.

Other differences between second and third generation features also provide reasons for converting data files. Standard file labels may be adopted as provided through features of the operating system. Some users employed volume labels previously, although special routines were necessary to do so. Sort routines may be converted to native mode operation even though the rest of the system runs under compatibility; the native mode sorts are considerably faster. Such changes require the use of disk or nine-track tape for specially created sort records and may require special precautions. Files may be converted to properly allow for character representation, the word length, and the fixed or variable length of the records in a file. The new collating sequence may be another reason for converting data files, assuring maintenance of the required sequence on the new computer system.

Approaches

Whatever the reason for the conversion of the data files or the difficulty of the change (just character translation to the new set or

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[37]Cartledge, "Program and File Conversion," p. 25.

complete reformatting of all data), three options are open to the user. The easiest conversion can be made possible by attaching seven-track tape drives to the new computer. The drives can be used for input during the first run of the program or system on the new computer. Output would be produced on nine-track tape drives, and a translation of characters would be accomplished without extra computer runs. Extra runs are required for other methods of file conversion. Utility programs or specially written programs may be used to facilitate file conversions. The utilities are general routines for simpler, character-type translations. Special, one time, programs can be used to make more complex file conversions where the order of the data, the format of some files, or even the content of the records or files require changing. The utilities or special purpose programs may be used to convert data files en masse or one application at a time. The seven-track tape method, however, is used only for file conversions done application by application. Timing is particularly critical when extra computer runs are required for file conversions, especially when the whole library of files must be changed at one time. The scheduling aspect will be discussed more completely in Chapter VI--the Conversion Plan, Implementation, and Evaluation.

The users represented in this study employed every file conversion method mentioned. Five firms had seven-track tape drives for varying lengths of time.[38] Some of these firms, however, did not use the drives just for file conversion assistance. Emulation runs can operate either with the seven-track drives--meaning no conversion is necessary--or with emulation mode nine-track drives, where a translation is required. Disk

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[38]Appendix II: Cases 5, 9, 15, 18, 19.

to disk conversions were performed by four of the firms. The disk to disk change was not as direct as a tape to tape conversion, because none of the users making the change had in-house tapes. Three of the firms had to go outside to locate equal disk drives on computers which also had tape drives.[39] The information was dumped from the disk onto the tape, which was then used to move the data onto 360 disk packs. For one firm, even this approach was impossible.[40] The Ramax disk cannot be moved to another location, as the drive and pack are one unit. The only alternative was to punch out cards containing the disk data and then read the data onto the new pack.

In addition to the device change, users also had to decide on a translate or change approach for their data files. Those applications remaining on emulation mode operations required translation to the nine-track emulation mode. Two firms rearranged the files for maximum disk processing efficiency, but otherwise translated the data.[41] The story is different, however, for applications changed over to native mode operation. Most of the users changing to native mode changed their file formats and concepts considerably. Unused data was eliminated, the organization was changed, and data base concepts were developed in the more extreme cases.[42] One firm which strictly translated its old files and storage ideas ran into trouble.[43] The firm had always processed one file per disk pack on its second generation equipment and continued to do so on the 360. This philosophy was changed shortly after discovering the inefficiencies

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[39] Ibid.: Cases 3, 8, 14.

[40] Ibid.: Case 23.

[41] Ibid.: Cases 11, 27.

[42] Ibid.: Cases 18, 24, 27.

[43] Ibid.: Case 8.

and the fact that the 360 disks held considerably more information than the old packs.

Many of the firms did not feel the file conversion of the applications changeover was of particular importance. Its role was generally underplayed or not even mentioned, except for the firms which experienced critical timing problems in accomplishing the change. Two factors may account for this post-conversion indifference: seven-track tape drives and comprehension of what had to be done. Seven-track tape drives were used either as the only emulation mode input/output devices or as intermediate devices enabling changeover after installation as each application came due for processing. Even intermediate use of these drives took the urgency out of the file conversion situation. The second factor is that the users understood what had to be done for file conversion efforts. The data base changes between the second and third generation computers were adequately spelled out even with the initial manuals. Furthermore, the changes were of a variety lending themselves to automatic translation with either utility programs or special purpose programs.

Standards

Standards aid the applications phase of the conversion under any approach, and may become part and parcel of the conversion. Generally there was not a high level of formality in the area of standards during the use of second generation computers. The change to third generation became a convenient time to make changes noted for shortcomings previously experienced. The area of standards includes technical and operations standards as well as documentation procedures.

Technical Standards

Technical standards might also be known as conventions and standards, because the techniques and capabilities of the new computer equipment are used most directly by the programming staff. Although these technical standards apply most directly to programmers, they also affect systems and operations personnel. A firm's technical standards can include restrictions on uses of the main programming language, core storage, peripheral devices, or anything which might directly relate to the use of the new computer from a programming standpoint. They may be unwritten programming practices.

Many of the technical standards can be set down as early as the feasibility study stage of acquiring a computer preceeding active conversion efforts. The configuration and operating system considerations imply basic standards. Information obtained in negotiation provides other standards bases. Revision of the standards must be continuous throughout the life of the computer, but will be especially important during applications conversion efforts. Lecht cautions the user on the formal development of technical standards:

> It is important to note that the preparation of standards in computer programming which provide the last word in how programming should be conducted, cannot be achieved without understanding the nature of programming; what it is, what it produces, what personnel do, what kinds of personnel do it, etc. Achieving a "fix" on these items is not an easy task in a fast-moving environment.[44]

Care must be taken to keep standards current with the needs of the data processing efforts within the firm.

Half of the users investigated have developed some technical standards either for or as a result of their experience with third generation

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[44] Lecht, Computer Programming Projects, p. 201.

computers. While some of the users slid into the development and use of technical standards well after installation of the new equipment, those who did so with the conversion process are of major concern. The firms developing their standards formally after the fact did so more to meet growth and change in the data processing department than to deal with the new computer system.[45] Problems relating to a lack of technical standards with second generation operations led some users to correct the situations along with installation of the new equipment. In other words, the conversion provided an "excuse" for making changes that were needed anyway. Four firms were in a position to update and make their technical standards more complete, as well as to adapt to the technology of the new computer system.[46] These firms did not have the additional difficulty of enforcing a new idea. Their programming staffs already used prescribed standards

Three of the companies previously developed comprehensive technical and overall standards to guide their conversion efforts as well as to serve throughout the life of their new computer equipment. One took a very strict approach to technical standards to help offset the problem of a fairly large number of inexperienced programmers and to standardize operations.[47] Two firms began formal development of extensive sets of standards during feasibility study efforts.[48] Technical and other standards developed have been updated continuously throughout the work with the new computer system. The data processing managers of these last firms

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[45] Appendix II: Cases 4, 7, 9, 14.

[46] Ibid.: Cases 10, 12, 19, 24.

[47] Ibid.: Case 18.

[48] Ibid.: Cases 2, 28.

directly attribute the success of their conversion work and later operations to the early establishment of comprehensive standards.

Operations Standards

Operations standards pertain more to running the computer and applications than to the programming side of EDP. These standards help direct the flow of data from users, within the computer room, and back to the users. Operations standards might include such things as who is allowed in the computer room, who handles the data, logging procedures for computer runs and input/output control, and tape recycling requirements.

Less attention was given to operations standards than to technical standards by the users investigated in this study. Only eight of the users even mentioned operations standards in relation to their total conversion, and half of them only began to set formal standards as need arose after the new computer was installed.[49] Two users made major operations changes which were foreseen during second generation use and anticipated a greater need with the new equipment. One firm went from a completely open-shop operation to a closed-shop set up, except for program check-out.[50] Under the new setup, programmers would be in the computer room only in blocks of allocated test time. The other firm making a major change initiated a complete control system.[51] The system required adding a new department within the EDP area. The control group was responsible for setting and maintaining controls for the conversion and all future operations. The standards they set covered programming and systems aspects that are

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[49] Ibid.: Cases 1, 4, 10, 22.

[50] Ibid.: Case 25.

[51] Ibid.: Case 12.

particularly related to operations, logging procedures, key punch control, general input/output controls, and tape library controls.

Documentation

Each user probably has a different concept of exactly what is included in documentation. A fairly complete documentation package might include the following items pertaining to a given system: system flow chart, system narrative, job narratives, program narratives, operating instructions and flow, program listings, key punch control items, printed forms, and revisions to the system once it has been implemented and changed. A package developed in this manner can be broken into parts which affect particular groups within the firm. A complete package, however, must be maintained by the data processing department.

Documentation can be a substantial aid throughout various stages of applications conversion. Knowing what information, files, and sources of data are used; how and when the information is processed; and what form the output takes can be used repeatedly. At minimum, some form of applications listing is necessary. The list can be used in decisions on the program conversion method, in scheduling program and file conversion efforts, and in review to see that all steps needed have been taken for all applications throughout the conversion. The order of the applications list is frequently based on some form of priority. Priority bases used include volume of data processed, frequency of use, importance to company business or management, and ease of conversion.

If the documentation is incomplete, non-current, or non-existent, the difficulty of the applications conversion increases significantly. Inadequate, incomplete, non-current, and non-existent documentation

situations are exactly what most of the users faced during conversion efforts. Of the firms which expressed concern about documentation, well over half fell into this category.[52] Eleven firms had no documentation at all, while five others had either verbal understandings or incomplete and scattered information available.[53] The lack of essential information during conversion activities, both for managers and programmers, led to changed documentation policies in connection with new systems for the 360 and applications converted to native mode operation. Although some of the users only found their way clear to document the old systems well after installation of the new equipment, others began requiring complete documentation packages with the programs worked on between the time of the order and the delivery. Only one firm with no pre-conversion documentation or standards continued to operate without them well after the conversion project.[54]

The other firms, including those who had second generation documentation, generally moved toward even more comprehensive documentation requirements. The most extreme situation is represented by one firm which had no documentation whatsoever for its old system.[55] The documentation packages for new systems were very thorough and were developed from the systems definition stage right through implementation. The documentation package, in fact, became the means of checking progress on each application.

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[52] Ibid.: Cases 15, 20, 21, 27 did not place any emphasis on documentation or other standards either before or after conversion.

[53] Ibid.: Cases 1, 3, 4, 5, 6, 8, 13, 14, 18, 22, 26 had no documentation; Cases 2, 7, 16, 25, 28 had incomplete documentation.

[54] Ibid.: Case 5

[55] Ibid.: Case 18

Incomplete documentation and non-current program listings were particularly dismaying to programmers who were involved in recoding and rewriting applications for the new computer. What should have been fairly straightforward efforts were complicated by not knowing exactly what the programs were to do. Two of the firms in this position were fortunate to have all the same staff members, meaning that the unwritten information was available.[56]

Even complete documentation packages must be reviewed during the conversion, especially if any change is made to its contents. If documentation changes are required, they must be made to each copy or segment of the package whether or not it is located within the data processing department. Documentation reviewing includes checking to see that all preprinted forms used for EDP functions are still acceptable.

Testing

Two stages of testing accompany the changeover to the new computer. The first is the computer system shakedown. Because shakedown operations are under the direction of the Customer Engineers and is a part of the normal installation procedures, it is of little concern here. The second stage of testing directly involves the user firm and is discussed in this section. Testing the user's applications on the ordered configuration, whether done before or after installation, provides the assurance that the systems will operate correctly under the new computer environment.

Applications testing includes elements of the operating system, the programs to be used and files to be processed. Checkout work on

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[56] Ibid.: Cases 1, 25.

the operating system becomes an essential concern of the user when he has done a considerable amount of modification work on it. A number of the users investigated in this study checked out the compatibility software, which they adapted to meet their particular needs.[57] Because the modified packages included parts of various systems releases or some of the user's own coding, they were not supported by the manufacturer and responsibility for them rested on the user. The users who found the package to meet their needs as it was, indicated little need to test the operating system features or the compatibility features.

The operating system and emulation capability testing is not done in a vacuum. These features must be checked out in conjunction with programs and files to be run on the computer. Those programs left essentially as they were on the old equipment are checked under emulation mode to see that they do act the same and produce the same results on the new computer. The programs which were changed to native mode operation and any new programs undergo the normal debug and check-out procedures on the new computer or one similar to it. Testing native mode systems may be only to see, in the case of translated or recoded programs, that the output matches that of the old program. On the other hand, the test for a drastically redesigned or new application will have to include source data, key punch, data control, and ultimate use of the output in addition to the operation of the programs on the new computer. Essentially the same things can be said for data file testing. Those files changed only through translation only need to be checked to assure that they are interpreted and updated as they were on the old computer. More care must

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[57] Ibid.: Cases 4, 5, 7, 8, 12, 17, 20 extensively modified the package.

be taken with new and changed files or files on new media.

Parallel runs served as the primary check-out device for users employing emulation or recoded programs from the beginning of their 360 operations.[58] The parallel run form of testing means that the two computers ran the same jobs simultaneously, with the same input. The output is compared for equality. The obvious difficulty with this approach to testing is that it takes considerable time to duplicate the efforts and check the results for so long a period of time. For most commercial systems, however, a month is a reasonable period of time to catch all the major functions of an application. Solomon and Weingart point out that while a new system may go into operation quickly, it will not be considered completely operational until a full processing cycle is completed.[59] Routines which require yearly or quarterly action would not be checked until their normal operations come due. Robert J. Van Ness takes issue with those insisting on parallel operations for adequate testing procedures. He prefers a pilot run in which all the activities for a single day are converted and processed through the new system. The output is thoroughly checked. He feels the pilot run gets the job done with all the advantages of the parallel run and none of the disadvantages.[60]

Some of the users investigated may have gone along with Van Ness as they limited their testing periods or indicated relatively little importance concerning the procedures. Two firms were completely changed

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[58] Ibid.: Cases 7, 10, 13, 15, 16, 17, 20, 28 ran parallel operations for a month before physically changing to the new equipment.

[59] Irving I. Solomon and Laurence O. Weingart, Management Uses of the Computer, (New York: Harper & Row Publishers, 1966), p. 171.

[60] Principles of Data Processing with Computers, (Elmhurst, Illinois; The Business Press, 1966), p. 205.

over to the new equipment and released the old within two weeks of the installation.[61] A sizeable group of users declined to explain the role of testing and their applications which were placed under emulation.[62]

Pre- and post-installation computer time directly influence the actual moment of changeover to the new computer. If it is possible to do all the preparation and testing necessary before the equipment is on site, implementation of the systems can occur immediately after the required shakedown procedures. Solomon and Weingart feel pre-installation check-out is a key factor:

> The entire program preparation phase is dependent upon the availability of time on a computer like the one ordered for the new system, both for preparation of the programs in executable form and for testing of these programs. . . . . object programs can be proved only by running them with representative test data on a computer that matches the one to be used in the new system.[63]

Although their primary concern is with new systems being implemented on a new computer for the first time, the ideas are applicable to conversion situations as well. The critical factor of the pre-installation testing activities is the availability of a computer like the one to be installed. Obviously, not all users would be able to locate a configuration "exactly" like the one they ordered. For those users converting during the first two years the 360 was out, the available computer time was limited. The IBM data centers were flooded with conversion activities, and there were very few users with computers on site with time to lease to the others expecting new machines. More than a third of the users did all of their

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[61] Appendix II: Cases 4, 21.

[62] Ibid.: Cases 1, 2, 6, 14, 18, 19, 22, 27, 28.

[63] Solomon and Weingart, p. 162.

testing on site after installation of their computer.[64] It was, therefore, impossible to change over their applications processing for some time. For the most part, these users anticipated the difficulty of obtaining adequate outside time and chose to do their preparation and testing when sizeable blocks of time were available on their own machines. Of the other users stressing the importance of test time, only one firm leased computer time from another user in addition to using data center facilities.[65] The remainder used data center time as well as some initial period following installation of their own computers.

It is important to note the activities to which users directed their attention during the period of pre-installation. Three users were primarily concerned with creating system tapes, emulation, and operating systems, for use on their own computers.[66] They felt it was essential to have the tape ready and available for use from the outset with their new computers. One firm worked entirely with procedures programs during its data center time.[67] The programs were a type of in-house utility variety which had become common routines for programmers to access from special purpose programs. Because of the number of programs affected by the procedures programs, they had to be available before the others could run correctly. Another firm developed and leased operation time for a critical system once it was completed prior to the installation of its own computer.[68] Two firms were able to complete most of their parallel testing

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[64] Appendix II: Cases 3, 4, 5, 8, 10, 11, 13, 20, 21, 23, 24.

[65] Ibid.: Case 15.

[66] Ibid.: Cases 7, 12, 17.

[67] Ibid.: Case 26.

[68] Ibid.: Case 25.

on outside, pre-installation time.[69] One firm, in doing debug and check-out work, discovered that its entire approach was inadequate.[70] Users who had pre-installation preparation and test time available on similar computers allocated their time to the things most critical to getting their own operation off the ground as soon as possible after installation. None of the users was completely ready to change over their activities immediately, once the new computer was operational.

An important aspect of preparation and test time on the computer, whether outside or in-house, is the training which the time provides. The time becomes the initial on-the-job experience with the new computer. The importance of this aspect of test time is discussed completely in the training section of Chapter V.

Implementation

Applications can be implemented on the new computer once the testing phase is completed. If the testing phase is inadequate, implementation and use of the applications on the new computer are complicated. Errors discovered during actual operations cause discontent among the user departments within the firm, and put added pressure on the data processing department. Quick program changes may be made to correct the errors of the moment without fully anticipating their total effect on the program and the system.

Implementation provides a particular problem in timing. The data processing operations of a firm normally cannot be interrupted for a very long period of time. The situation becomes critical when the entire

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[69] Ibid.: Cases 15, 16.

[70] Ibid.: Case 9.

library is to be affected at one time. If the applications are to be implemented over a period of time, special care must be taken when a "converted" system feeds information to or receives data from an unconverted one. Proper order of implementation is essential to the smooth operation of all data processing functions.

Summary

Applications phases of the conversion project cover action taken in regard to programs, files, standards, and testing and implementation. These activities are at the crux of the entire conversion.

The approaches taken to the conversion of the firm's program depended upon the basic objectives of the conversion as well as action outside the data processing department. Basically, the users followed one of three main objectives: hardware-oriented activities; hardware considerations plus new applications; or software considerations and new applications. Emulation was the most frequently used approach with some users choosing to emulate permanently either a portion or all of their second generation programs and others choosing to emulate as an interim step to completely converting their programs to native mode operations. A smaller number of users chose to implement new or redesigned systems with their initial use of the new computer equipment. Since completing their conversion project, over half the users who decided to use emulation on a permanent basis have either decided or been forced to eliminate the emulation mode of operation. The actual approaches to program conversion taken were different from those planned by half the users. Company-wide action which over-rode data processing priorities and inadequate basic decisions on the computer system to be

used were the primary reasons for changing the planned approaches. All the changes enacted provided more comprehensive use of the 360 system, required more work, and resulted in greater pressure to get the conversion project completed.

Relatively little concern was indicated in relation to file conversion efforts, except where timing and outside equipment were critical. The relative lack of concern may be attributed to the availability of seven-track tape drives on the 360 and to an adequate understanding of the data differences between the second and third generation machines. Timing the file conversion step was of particular concern when general purpose character conversion programs or special purpose programs were required. In these cases new files had to be created and tested before the application could be run on the new computer. In a few cases outside time and special equipment were required.

Two factors are important in the area of standards: second generation inadequacies and conversion guidelines. Technical standards, operating standards, and documentation were essentially inadequate or completely missing in second generation EDP operations. The users, mostly because the conversion provided a good opportunity, moved to correct the inadequacies in the area of standards. All but one added or improved documentation primarily because its value fully came to light during the conversion. Some of the users developed extensive technical standards from the beginning of their conversion efforts. While updated continuously, they served as critical guidelines during the conversion and were cited as key factors in the success of conversion completion.

Testing and implementation are the last two steps of the conversion process. None of the users were able to complete their testing

before installation of their computers, meaning that all experienced considerable in-house test efforts. Some firms, in fact, did no testing whatsoever before the installation of their own machines. The scope of the test phase was dependent on the approach taken to program conversion. Obviously, as the extent of the changes increases, the comprehensiveness of the test phase following increases. If implementation and use of the program occur before adequate testing is completed, excessive program maintenance and user dissatisfaction become major problems.

CHAPTER V

CONVERSION AND PEOPLE

People, not the computer, make conversion work. It takes people to plan, carry out, and evaluate a particular conversion. The process is far from a mechanical one. In order to deal with a conversion, the people involved must be prepared for their tasks and relate to the others affected throughout the process. The relationship of the people involved in the process and conversion will be discussed in this chapter. The first order of importance is directed to explaining just who may be involved in the conversion. Knowledge of who is connected with conversion leads to discussion of the training of these people. Finally, attention will be given to the role of organizational factors in the conversion process.

Who Is Involved

Many people, both inside and outside the firm, are involved with the conversion process. Although representatives of the computer manufacturer and the members of the EDP staff are most directly involved, the entire user firm may be affected by the end results of conversion. The roles of the manufacturer's representatives, the EDP staff, and others in the user firm are presented in this section.

Manufacturer Representatives

Persons of primary concern to the user during the conversion process were the Customer Engineers and the Systems Engineers. Although the Sales Representative was continuously available and in charge, Customer and Systems Engineers worked daily with the real conversion situations. The normal procedure was for a team of manufacturer representatives to be assigned to a firm throughout the conversion effort. While the number of people assigned to the team and the frequency of their visits to the user firm varied with the complexity of the conversion from the manufacturer's standpoint, there was at least one Customer Engineer and one Systems Engineer working with each situation, with the Sales Representative as the coordinator.

"Customer Engineer" and Systems Engineer" are employee designations unique to IBM. This means that their individual duties may differ from those performed by specific representatives of other manufacturers, but the basic duties performed would be provided through some means by another manufacturer. The Customer Engineer, or C.E., is the key person with regard to the computer system per se. His responsibilities include installing, getting into operation, and maintaining the computer system's hardware and operating system. Specifically, in relation to conversion efforts, the C.E. provides expertise in computer room preparations and layout, physical setup of the new computer, and diagnostic runs or the initial shakedown work. The C.E.'s are most concerned with the operation of the computer as intended by the manufacturer. The Systems Engineer, or S.E., on the other hand is directly concerned with the user's staff and applications. His job is twofold: to help develop the capability

of the EDP personnel; and to help get the user's system running efficiently and effectively. During conversion the S.E. performs a variety of duties including formal and informal training, systems counsel, and technical debug assistance.[1]

The fact that manufacturer representatives were available and used by the firms undergoing conversion must not be overlooked. The role they play points out the close relationship between the manufacturer and the user firm, especially during conversion. All but one of the firms investigated employed the expertise of the C.E.'s and S.E.'s to some degree.[2] Although the purpose of this study is not to evaluate the specific functions performed by the manufacturer or its representatives, the functions must be recognized. The few users citing the services, especially those of the S.E., did so to comment on extremes. They reported either much more service than anticipated or some feature of service which they had expected and had not received.[3] The great majority of the users, 79 per cent, had nothing in particular to say in regard to the personal aspects of manufacturer support. The attitude projected was that they received the service they expected.

While users received support from the manufacturer's representatives, the conversion project was basically in their hands. Solomon and Weingart rightly point out:

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[1]Joseph A. Whalen, "Installation Backup...Systems Specialists," Data Processer, April, 1966, p. 15.

[2]It was the policy of Case 27's data processing manager to avoid the personal aspects of manufacturer support.

[3]Appendix II: Cases 3, 16 cited exceptional work while Cases 7, 8, and 17 cited particular areas of inadequacy to their judgment.

> The user is ultimately responsible for continued operation of the new system, and therefore must plan and carry out his preparations, with assistance from the equipment supplier to achieve that goal.[4]

The role of the manufacturer's representatives must be kept in proper perspective as a support feature.

EDP Staff

Whatever the objectives of the conversion, the EDP staff plays a major role in the process. The applications and physical parts of the process are directly under their domain. Programming changes, the peripheral device changes, and layout of the computer room are the obvious responsibilities. In order to understand the responsibilities of the EDP staff members, the discussion will cover the way in which particular staff members fit into the conversion picture and what staffing changes were made for the conversions studied.

Just as the objectives of the conversion help set out the work steps required, they also help determine the role the various EDP staff members will play. Those conversions which involved emulation primarily required the direct work of the programmers and the computer operators. Conversions at the other end of the scale, involving comprehensive redesign, required the work of systems design, programming, operations, and control and key punch. In any event the data processing manager is in a position of coordination and control.

An EDP staff performs functions of systems design, development, implementation, continued operation and maintenance. Although the size of the data processing operation determines different positions these

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[4]Solomon and Weingart, Management Uses of the Computer, p. 150.

basic positions will be used: Systems, Programming, Operations, Control, Keypunch, and EDP Management. The positions will be discussed as though unique individuals occupy them. It is not uncommon, however, for the systems and programming duties to be combined or for the operations and control functions to be carried out by a single individual per shift.

Systems. Systems analysts are a factor in conversions which include a substantially redesigned or new system to be implemented with the conversion. They may also be considered part of the conversion picture when the systems prepared between the order and delivery of the new equipment are for native mode use on the new computer. Their objective in such design is to balance the system's needs with the computer's capabilities. Neither system nor computer can be considered alone.

Programming. Programmers become directly involved in any conversion. They must make the technical changes necessary to run the programs on the new computer, regardless of whether the programs run under emulation or native mode. All users investigated intended to put their new programs on the computer in native mode. While some did not plan to write any new language programs until the new equipment was installed, others were writing all systems developed between the order and delivery for the new computer. Programmers, therefore, needed to know both the types of changes or other features needed for emulation runs as well as the new programming language and technical facets of the computer's operating system.

Operations. The computer operators became involved in the conversion project whenever the firm was ready to begin testing programs on the new computer or a similar computer. For some operators this meant

their initial work was at the data center or on a leased computer elsewhere, but for most it was not until the firm's own computer was installed and running. In order to do his job, the operator needs an understanding of the flow of the programmed system and the operating responses and requirements of the computer system.

Keypunch and Control. A lesser role is played by keypunch and data control personnel during the conversion process. The conversion may also have been accompanied by a change of keypunch equipment. New card punching equipment was developed for the 360 to handle the new data base and some special characters. However, the old keypunch machines could be used by making the correct multiple punch for the changes and characters which were not available directly on the keyboard. Keypunch personnel, then, were required either to learn a new keyboard and machine or to learn the correct multiple punches for the characters not on the old keypunch machines. The changes for conversion required by the firm's data control group depended upon the action taken with regard to the applications and the scheduling differences for operation on the new computer. Control includes source and final data as well as the necessary tapes, disks, and operating procedures. If none of these elements were changed for the conversion, then there was no change for control procedures. But as indicated previously, all firms investigated experienced at least some peripheral device changes requiring new tapes, disk packs, and similar media.

EDP Management. The data processing manager's functions for conversion are no different than those of any other manager. He must plan, coordinate, control, implement, and evaluate the conversion process.

Again, the purpose of this study is to identify those elements with which the data processing manager must work during the conversion. His role is the primary concern of this study. Briefly, he must align the activities and resources required within his own department and from outside.

The Firm's Staff

Almost everyone in a firm which has a computer is affected by the machine to some degree. Although a given employee's contact with the computer may be only the automatically generated pay check which he receives, he is aware a computer is involved. Word of a computer conversion will likely filter to even those very indirectly involved. Anxiety and close scrutiny of computer output, such as the pay check, can be expected from everyone.

The in-house users can also be expected to show some anxiety and examine the output from the new computer more extensively than had been done previously. For those firms whose conversions included systems redesign or the addition of new systems, the user is involved in the development and testing phases, and becomes more directly involved in the conversion process. It is only normal for the users to wonder why the conversion is taking place, what will be done, and how it will affect them.

The conversion project may also reach some employees in other respects. If in-house maintenance or building crews are available, they will be responsible for preparing the site for the new computer. Should the conversion be accompanied by a change of location for the computer or the EDP staff or an increase in the area occupied, people may be moved

out of their offices to accommodate the needs. Such indirect aspects of the conversion may also result in anxiety or animosity among the employees unless handled properly.

Staffing Changes

In addition to the duties performed during the conversion procedure by various staff members, it is important to notice any changes made in regard to the size of the staff involved. The addition of new members causes additional burdens of training, because the new people are likely not to be familiar with either the firm or the data processing procedures used. In the case of trainees, the problem is even greater, because they will have to be taught basic concepts as well as conversion requirements and those factors unique to the particular firm.

The concern in this section is with increasing the EDP staff or changing the staff size in depth. None of the firms investigated reduced the sizes of their staffs for conversion. Staffing changes outside the EDP department are not likely to have a direct bearing on the conversion and are not within the realm of the data processing manager.

More than a third of the firms investigated did increase portions of their EDP staffs for the conversion. All had started the build-up well before installation of the new computer. More programming help was required by four of the firms. Only one of the firms chose to get the added manpower through the use of outside consultants.[5] Two firms hired experienced programmers and one hired an inexperienced staff to train as coders.[6] The latter case had the greatest overall change in

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[5]Appendix II: Case 8.

[6]Ibid.: Cases 7, 9, 18.

staff size. The data processing department grew from four employees at the time of the order to twenty-five 18 months after the installation. The growth was part of the conversion activity. One firm was only interested in increasing the size of its operations staff.[7] In addition to hiring two more operators, a person with 360 operations experience was hired as operations section manager. The remaining firms which increased the sizes of their data processing staffs did so in more than one area. For instance, one company added both operators and programmers.[8] Another firm added a systems manager, three programmers, and a data processing department manager.[9] The data processing manager was the last to be added to the staff, and he came less than two months prior to installation of the new equipment. Three companies almost added completely new departments. Due to merger upsets and job security anxiety, one firm lost all but its data processing manager just prior to installation.[10] Programmers and others were located through trade schools, and none had any previous practical experience. Another firm was bringing its operations back to an in-house operating environment.[11] Key punch was the only phase of the computer operations which was done by and within the firm prior to the conversion; systems analysts-programmers and operators were added once the supervisory staff was established. The last company was adding centralized data processing facilities which were new to the

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[7] Ibid.: Case 26.

[8] Ibid.: Case 25.

[9] Ibid.: Case 3.

[10] Ibid.: Case 20.

[11] Ibid.: Case 13.

decentralized, local operations used prior to the conversion.[12] This firm also needed to develop a complete, parent company staff once the supervisory staff was assembled.

The other firms studied either felt their existing staff was adequate for the conversion project, or they were limited to working within the limits of their staff. Three of these firms required additional personnel after the initial use of the new computer.[13] It must be noted that even with those adding staff members before the conversion, there was a general expansion of EDP activity, not merely the conversion to warrant the growth. However, growth which occurred during the conversion process, regardless of the reason, added to the complexities of conversion and to the factors which must be considered in planning for the conversion.

Training

Training is whatever prepares those within the firm for conversion; therefore, training includes the briefest orientation as well as very technical formal training. An orientation session might be held to explain to an entire firm basically why the conversion is being made and how it will affect the company as a whole; or an orientation may be informal discussions with various groups concerning the ultimate effect of the conversion upon them. On the other hand, training for the EDP staff may be quite complex--including formal classes, self-instruction manuals, seminars and on-the-job training.

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[12] Ibid.: Case 28.

[13] Ibid.: Cases 5, 6, 14.

Importance of Training

Basically there is a twofold importance to training in preparation for conversion as well as during conversion: learning to use the new computer system and preparing for the change involved. Behind both are the people who must make the conversion work. It is normal for people to resist change, and overcoming this resistance is the initial training target. Training, both on the general and technical levels, can help overcome resistance to change and increase the likelihood of efficient operations from the beginning. Basic principles of training must be kept in mind, whether the program is for general orientation throughout the firm or specific instruction within the EDP staff.

As P. T. Smith puts it: ". . . no computer system--however well designed--will function properly unless the personnel who support the computer want it to work."[14] Everyone concerned needs to understand the general situation, the advantages to be derived, and only then what his role is to be.[15] Although the observations were originally meant to apply to initial computer systems development, they are completely applicable to conversion situations as well. While many will argue that no one in the firm other than the data processing staff is involved in an emulation-type conversion and that it is unnecessary to consider the entire staff of the firm, the argument is fallacious. The computer is still too much of a novelty and an element of awe to presume that merely shifting operations to a new machine will not affect the majority of the firm's employees. Sooner or later, almost everyone will hear about

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[14] Computers, Systems, and Profits, (n.p.: American Management Association, 1969), p. 3.

[15] Frank Greenwood, Managing the Systems Analysis Function, (n.p.: American Management Association, 1968), pp. 3-4.

the change. It will be normal for many to be suspicious of the new equipment, even to the point of concern over job security. Overcoming this type of reaction is as important as the direct technical training for the use of the computer system. Orientation sessions can serve to counter most of the sort of reaction mentioned.

Technical Training. Technical training is just as critical as orientation. Baker emphasizes the point: "In the lines of computers that are now offered, training is not a luxury; it is a necessity."[16] Technical training is a necessity to systems designers, programmers, operators, managers and users within the firm as well, although each requires a unique level of understanding. According to his needs, each will require a knowledge of the new computer system, how it differs from the old, and implications of its use in the future. An example is the technical training program which was carried out by the Schenectady conversion of the General Electric Company.[17] While the Schenectady conversion was on a much larger scale and to equipment other than that investigated in this study, it is the only documentation available concerning training programs developed specifically for conversion projects. Education and training continued to be the responsibility of the Software Systems and Techniques Group during and after the conversion. The group undertook an intensive program directed toward efficient use of the new computer with the idea of preparing data processing staff members for the conversion at hand and the users for future challenges. Various in-house courses were developed for the programmers requiring books, homework,

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[16]"Economic Considerations of Conversion," Datamation, June, 1966, p. 3.

[17]Mario V. Farina, "Training for Conversion," Datamation, June, 1966, pp. 27-29.

and actual on-the-job work as well as formal classes. Special subjects were covered in courses developed by popular request. Correspondence courses were also available through the Software Systems and Techniques Group. Series of courses were also developed and geared toward the needs of managers and offered on a voluntary basis. Operator training was initially done through the Software Systems and Techniques Group, although those trained in the beginning were trained with the idea of their developing and carrying out all future operator training. All other courses are still offered through the Software Systems and Techniques Group. The group handles the courses and special training devices. Publications and recorded lectures are among the special training devices used and developed. The publications range from complete correspondence courses to special topic bulletins and pamphlets.

Basics. Regardless of whether a specific element of training is geared toward the orientation idea or the technical needs, the essentials for success are known. One is the selection of those persons responsible for training others--the number depending upon the size of the computer operation and the firm. The other is the set of training devices which will be used in each instance.[18] The training devices generally include formal classes, on-the-job training, written documents, other intended communication, and participation. The role of participation should not be slighted; resistance frequently arises through lack of participation from those within and outside the EDP department.

The Training Done

The training procedures actually employed by the users studied

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[18]Greenwood, Managing the Systems, p. 11.

are presented in this section. Because different approaches and needs were used for various groups of employees, the discussion will be broken down into major employee classifications: programmers and systems analysts, operators, users, and others. Within each area, the critical elements of training, who was in charge, and what the training devices were are presented.

EDP Managers. In all but the largest of the data processing operations in this study, the data processing manager was directly in charge of systems, programming and operations. Some managers acted as player-coaches. These managers were directly involved in implementation of the conversion plan and were in training situations both as managers and as programmer analysts. In the larger organizations the data processing managers could take a more general approach to their own training. The manager of each area could concentrate on the aspects which most involved his responsibilities.

Obviously, in the case of a single level of data processing management, the manager must be in charge of his own training program; therefore, the activities undertaken for this purpose are of concern. Of those data processing managers indicating the importance of their own training, the majority limited their studies to schools at the manufacturer's education center, programmed instruction courses, and various 360 manuals.[19] The training of these data processing managers was undertaken either during feasibility study stages or well before others were to be formally trained. The information was used to help select courses for programmers, analysts, and operators to attend or to develop

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[19]Appendix II: Cases 8, 11, 17, 19, 22, 23, 26.

in-house training programs of their own. In three of the cases, training also served as a basis for technical work performed during the conversion.[20] Two of the managers indicated that the local Data Processing Management Association (DPMA) seminars were a great help in their understanding and resulting management of the conversion project.[21] A brief series of DPMA seminars were held weekly for three months during 1966 which helped the participants see their own problems and foresee others from the discussion sessions. Two other managers did extensive research through all available sources beginning in the feasibility study stage preceeding the actual conversion process.[22] In these cases the manager's concern was development of a comprehensive standards manual to guide the entire process from the beginning. Once the initial development was completed the manuals were continuously updated with information from all levels of data processing as well as from the manager. Unique training programs were available to the managers of the two firms involved as segments of a national conversion.[23] These managers were exposed to data center courses and to extensive programs developed by their parent operations.

Three of the cases studied mentioned specific action taken for middle managers in the data processing department. In these situations experienced operators were located to head the operations section of the department.[24] By hiring operators with 360 experience, the firms felt

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[20] Ibid.: Cases 8, 17, 23.

[21] Ibid.: Cases 4, 7.

[22] Ibid.: Cases 2, 28.

[23] Ibid.: Cases 10, 24.

[24] Ibid.: Cases 8, 22, 26.

they also took care of the training of the rest of their operations personnel. While finding experienced operators was much simpler for those converting later, one of these conversions took place in June, 1966, relatively early in the existence of 360 equipment on the market.

Programming and Systems. Although programmers and systems analysts require different levels of understanding concerning a computer system, they are treated together. The primary reason for doing so is that many of the firms investigated employed programmer-analysts rather than two distinct skills. Where specific differences in the training did occur, they will be noted.

Three types of training material were available from the manufacturer: formal schools or classes at the data or education center, programmed instruction courses, and the 360 manuals themselves. Only one of the users chose the PI course route for its programmer-analysts.[25] On the other hand, all but one used the facilities of the education center for formal classes. Half of the firms relied on these classes as their only programmer and analyst training for use of the 360.[26] There was no pattern of course selection shown by the users. Some concentrated on the operating system they would use, others on the programming language, and still others had their staff taking all courses which were available and offered at the time of their conversion. Two of the firms using only manufacturer training devices for their programmers indicated special followup situations. One relied most heavily on a full time in-house S.E. for the two years following installation of their equipment, meaning that

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[25] Ibid.: Case 23.

[26] Ibid.: Cases 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 17, 18, 21.

informal training through consultation continued for a considerable time.[27] The other firm's analysts, the programmer-analysts in second generation, tried to write systems definitions which were almost self instructing. The newly hired programmers were to be coders.[28] In these cases training was the responsibility of the data processing manager.

On-the-job training in something like programming is really at the crux of the learning process. In this case actual use of the computer provides the opportunity to test any formal learning in life-like situations. Certainly all the firms interviewed realized the role of on-the-job experience for the programmers; however, only four firms provided for such training within their schedule of the conversion process.[29] Formal training was done through the manufacturer's education center. Two firms had some training during the use of IBM-1410 computers. The intermediate 1410's had COBOL capabilities and some basic operating system features which introduced and prepared the staff for 360 operations.[30]

Two situations represent a further step in training. Both cases set up special in-house programs which they considered beneficial to their conversions and continued operations with the 360. One initiated work-class sessions beginning with actual computer operation and ending with discussions of the new ideas in programming and systems design techniques.[31] The program has been run periodically since the initial set

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[27] Ibid.: Case 16.

[28] Ibid.: Case 18.

[29] Ibid.: Cases 1, 13, 26, 27.

[30] Ibid.: Cases 12, 22.

[31] Ibid.: Case 25.

held for conversion, with later sessions of the refresher course variety. The other company put together an in-house course to concentrate on features of the operating system which the programmers and systems analysts particularly needed to learn and understand in order to use the computer system efficiently.[32] The program was handled by the programming manager.

The remaining four users had multi-faceted training programs. Three of them combined the formal schools with highly developed in-house training devices. The two firms which converted as part of a national conversion took part in highly structured courses presented through the data processing department of the home office. Extensive in-house manuals on techniques, problems, and new systems further supplemented the formal training. The testing time in both situations was to serve a double purpose. It was as important a training device as it was a checkout device. Home office staff members were present to assist with both aspects of the test procedures.[33] Extensive standards manuals also characterized a major training device for the other two situations. Enforcing rigid standards and convincing the employees of the necessity of the standards went hand in hand with the training program for one conversion situation. The manager in charge of all applications and various members of the central data processing staff for the firm carried out the training necessary in the central office and in the subsidiary user firms. Much of the time was devoted to changing everyone's thinking from card processing orientations to the greatly more sophisticated teleprocessing environment of the new computer.[34] The remaining firm assigned education responsibilities

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[32] Ibid.: Case 11.

[33] Ibid.: Cases 10, 24.

[34] Ibid.: Case 28.

to a technical support group.[35] The blend of devices they developed has been used since, in keeping with a belief in continually updating technical knowledge for all employees. The group investigated all available training sources: manufacturer, service bureaus, colleges, correspondence courses, et cetera. The best possible outside sources were used when in-house training was not feasible. Extensive in-house courses were formed, including the use of video tape facilities. On-the-job training was in the overall plan. The contents of the various courses were designed for specific needs of programmers, analysts, operators, or users. While user and operator training is discussed later in this section, the situation is unique in that the one group handled and designed exact programs for every area affected by the conversion. The group continues to handle current educational programs for all levels of employees.

Operators. In half of the cases operator training was a minimal, informal effort done on the job. There was no set of information which seemed necessary to present to the operators. Whatever instruction occurred in these cases was through the S.E.'s during the manufacturer's shakedown runs.[36] It is important to note that many data processing managers later felt that their operators really needed competent training to adequately handle the computer, especially in interpreting console messages produced by the operating system. One of these firms in particular has recently undertaken an intensive program to teach operators the "whys" of the operating system.[37]

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[35] Ibid.: Case 1.

[36] Ibid.: Cases 1, 4, 5, 9, 13, 14, 15, 16, 17, 18, 19, 20, 21.

[37] Ibid.: Cases 4.

One group of users held some in-house sessions for the operators just prior to installation and on-the-job experience.[38] The formal sessions ranged from a few meetings and a one-day program to a five-month indoctrination before installation. One of the users indicating more specifically what operator training consisted of, strongly emphasized basics about the operating system and operating system messages and responses.[39] In another situation the programming and operations managers developed a program to introduce the operators to the 360 as well as to the operating changes which would accompany the conversion.[40] Most of these users emphasized that a prime purpose of the initial testing period was for operator training.

Basic operating system schools at the education center served as a main operator training vehicle for another group of users. Although one of these users indicated the school was the only real operator training, the others combined the school with in-house programs.[41] One program was informally conducted by the operations manager who had been hired with 360 operating experience.[42] Another program was an integral part of a lengthy test period supervised by members of a home office installation team.[43]

Other EDP Staff Members. Keypunch and control groups are also considered a part of the EDP department. None of the firms interviewed

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[38] Ibid.: Cases 7, 10, 11, 25, 27.

[39] Ibid.: Case 11.

[40] Ibid.: Case 12.

[41] Ibid.: Case 22.

[42] Ibid.: Case 26.

[43] Ibid.: Case 24.

thought training was of particular importance in relation to the keypunch section. As already pointed out, the keypunch operators faced, at minimum, a new keyboard or special punching techniques on the old keypunch machines. Many also had new input formats to punch from old and new source documents. The data processing manager's lack of concern with keypunch training may be attributed to one of two things: a keypunch supervisor who assumed the responsibilities completely or an assumption of inconsequential changes.

A similar situation existed in relation to control groups. Although many firms did not have control groups at the time of the conversion, some did initiate them shoftly afterward. In one case the group was created to help handle the conversion process and to see that 360 operations continued smoothly. The group's training was initiated under the operations manager who wrote up the specifications for the group and suggested policies. From that point on, the group developed its own policies and tools of operation, with the approval of the operations manager, and trained others in their use. This was the only case of specific training of control personnel prior to or during a conversion.[44]

Users. User involvement in the actual conversion ranged from none to total; likewise, their training ranged from none to complete. In fact, in some cases the user was almost intentionally avoided in the entire process. More than a third of the firms did not involve users in any way during the conversion.[45] Users in one firm were involved in a sort of negative way.[46] Their only role was indirect. They were

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[44] Ibid.: Case 12.

[45] Ibid.: Cases 6, 7, 9, 14, 15, 17, 18, 19, 26. 27.

[46] Ibid.: Case 11.

given only new input and output formats by the EDP department; the rest was left up to them. The users were not involved in the plans, the testing, or any communications concerning the conversion, but were expected to know the whys and wherefores of the new input and output forms at the date of implementation. The middle range involved users in the conversion to some degree. Admittedly, some of the users were not directly a part of the conversion process--nothing was being done to change their particular applications. Yet these users were told the reasons for the change and were kept informed on the progress of the conversion.[47] To some extent, calling such orientation "training" is stretching the point, but under the circumstances, orientation was all that was needed. Those users with applications being changed as a part of the conversion were included in the process as more direct participants. For some of these users, all of their training was through involvement and work with the programmers and analysts. Oral communication and participation in the planning, testing, and implementation became the training for these users.[48]

It is important for users to know their own errors as well as to identify EDP problems arising from the change. Some of the users participated fully in tests to assure that the bigger problem areas were resolved before changing to the new system.[49] Another group of users combined participation and EDP-use interplay with written procedures and reference guides.[50] In a special case, an implementation group was formed

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[47] Ibid.: Cases 12, 16.

[48] Ibid.: Cases 2, 3, 8, 21.

[49] Ibid.: Case 2.

[50] Ibid.: Cases 13, 25.

to see that the user-EDP communication was complete for implementation of conversion systems and for future systems as well. The group was to coordinate user and EDP activities and see that each understood the other's needs and actions. The group also handled the written elements required.[51]

Four of the firms investigated had particularly comprehensive training schemes for the users. Each possessed unique elements and will be discussed separately. The first case combines applicable classes outside the organization, participation, and post-installation orientation in its user education program. Different individuals were brought into "training" according to the time their involvement with the conversion was to begin.[52] Most of the education program for the users of a second firm was based on a major system being installed as part of conversion. The data processing manager developed manuals, reference guides, and class sessions as a part of the training program. Again, the programs were tailor-made for the various roles played by the users. Managers were presented general and specific information earlier than were other members of the firm. The system affected nearly every employee directly. To assure that everyone understood his role and the system, classes were held after implementation as well. Continuous training sessions continue for new employees and as refresher factors.[53] The last two inclusive user training programs were carried out by the firms involved in the nation-wide conversions. In both cases users were trained and prepared

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[51] Ibid.: Case 22.

[52] Ibid.: Case 1.

[53] Ibid.: Case 23.

for the conversion by the like department in the parent firm. In other words, the parent accounts receivable department was responsible for seeing that the local accounts receivable department knew its role. Both took pains to do extensive systems testing from the user through the EDP operations and back to the user. Help was available to correct the difficulties and to make sure everyone knew what was going on. One company held class sessions for the users to supplement the participation aspect. It also held company-wide orientations for everyone. The idea of these sessions was to assure an attitude which would permit successful implementation of the entire conversion, something which was learned by error in the previous conversion.[54] The other company also had local conversion teams to help in user training for the conversion.[55] In both cases, there was considerable communication between parent and local departments and between local EDP and the local departments. Formal standards, memoranda, lecture sessions, and informal discussions were used.

Organizational Factors

Two levels of organization can affect the conversion process: that of the data processing department itself and that of the firm. The discussion will center on significant changes or events which related to, or affected, the conversion.

Data Processing Organization

In considering the organization of the data processing department, emphasis will be on changes of duty or major shifts in the organization

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[54] Ibid.: Case 24.

[55] Ibid.: Case 10.

to accommodate the conversion and future operation of the new computer, rather than on staff increases, discussed in the previous section on Staffing Changes. Two-thirds of the firms interviewed did make some EDP organizational changes to assist their conversion project. Some made temporary changes for the conversion alone, but others made the changes to aid conversion and their continued use of the 360.

Among those firms which made some temporary changes were users who divided their programming staffs into two groups for the duration of the conversion.[56] One group was assigned entirely to maintenance of old programs, whether they were run on old computers or under emulation on the new computer; the other group was assigned entirely to conversion projects. They worked with new programming languages and prepared new and old systems for native mode operation on the new computer. The advantage cited most frequently was that the conversion group of programmers was completely free to work on programs for the new computer only. The conversion group was not bothered with day-to-day operations, maintenance problems, and having to switch between two or more programming languages and perhaps even logic patterns. Once the programs were all operating under native mode systems, separate conversion and maintenance group schemes were dropped by all except one of the firms.[57] The one firm felt it was advantageous to continue separating maintenance and new program development programmers. Another firm divided its programming staff, permanently, into a new development and a maintenance group. However, the maintenance group was assigned the job of converting all

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[56] Ibid.: Cases 1, 2, 7, 23, 26, 27.

[57] Ibid.: Case 2.

existing programs.[58] The breakdown is interesting because the development of new programs and systems was not a primary goal of conversion. This firm felt having the maintenance group work on the conversion of existing programs would allow the maintenance programmers to continue with the programs with which they were already familiar, even though the day-to-day operations would take precedence to any conversion projects.

In yet another case where change directly involved the programming function, job concepts were altered. Under the plan for second generation operations, programmer-analysts performed systems design, programming, and software techniques functions. The concept was changed for all third generation operations. The original programmer-analysts became systems design people or specialists in software techniques. Programmers were essentially eliminated from the picture and coders were employed to code the systems design output.[59]

Software techniques specialists were the concern of some users from the beginning of their 360 conversion preparations.[60] While titles varied from one firm to another, software specialists were often charged with learning the new operating system thoroughly and with developing commonly used routines or in-house utilities. The position of software technique specialist did not exist previously for the users. Creation of this job may have indicated considerable foresight, especially considering that other users found it necessary to add the specialty to

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[58] Ibid.: Case 11.

[59] Ibid.: Case 18.

[60] Ibid.: Cases 10, 24, 28.

their staff shortly after installation.[61] In addition to handling the technicalities of the operating system and in-house utilities, specialists were frequently charged with technical training for programmers, analysts, and operators, during and after conversion.

Training and communication were the goals of teams created by some firms to assist the conversion process. In two cases the teams were temporary features and were dissolved once the conversion was completed.[62] In one case, the team was made up of a member from the user department, a programmer, and a coordinator. The coordinator was competent in office administration procedures, not data processing factors as such. One firm started an implementation team to coordinate EDP-user interaction and training for the conversion projects.[63] The team has become a permanent group within the data processing department.

Input-output control is a function which evolves out of growth as well as increasing sophistication. Two firms found it necessary to add this function to their data processing departments to help with the conversion project and during all future operations.[64] Another found it needed to add a control section shortly after installation of their new equipment.[65] The groups were to initiate, maintain, and insure future control of all data within the data processing department and the flow of data to and from user departments. In these cases, conversion may have provided the necessary impetus to a change that was not necessary

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[61] Ibid.: Cases 1, 2, 16.

[62] Ibid.: Cases 10, 24.

[63] Ibid.: Case 22.

[64] Ibid.: Cases 2, 12.

[65] Ibid.: Case 6.

just for the conversion or just because of the new computer system. The EDP organization and operation had grown to a point where formal control procedures were necessary.

Growth and the increasing sophistication of the 360 provided the impetus for four firms to increase the levels of management within the data processing department. Prior to conversion preparations, these firms had a single level of data processing management--the data processing manager. The departments were reorganized into separate sections with section managers both to facilitate the conversion and to accommodate the growth and increased sophistication within the data processing area.[66] While none of them broke into the same data processing sub-sections, programmers, analysts, operators, and keypunch operators were involved.

Two companies had to develop complete data processing organizations. In one situation, data processing operations were being brought back in-house after the use of a service bureau.[67] In the other case it was necessary to create a central data processing staff for a teleprocessing system which would allow subsidiary firms to use common facilities. Before the conversion, there was no processing by or through the parent organization.[68] A special situation arose for a third firm which, in effect, required building a completely new staff. Everyone except the data processing manager quit during merger negotiations, and following the announcement. The result added havoc to a double conversion situation;

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[66] Ibid.: Cases, 3, 11, 20, 25.

[67] Ibid.: Case 13.

[68] Ibid.: Case 28.

the data processing activities for the two firms had to be compatible and then had to be run on new equipment.[69]

Company-Wide Organization Factors

Because data processing activities are felt throughout a firm, the influence of the company upon them cannot be overlooked. During a conversion the effects of the company on data processing activity can be even more influential. In this section the following topics will be discussed: changes of products or services offered; major changes in organization structure; support of the conversion.

Product or Service Changes. Unless a new product or an added service is within the bounds of the current data processing systems, the decision to include a new factor during the conversion process can complicate that process. Eliminating a factor is not likely to be much of a problem, but a far-reaching addition may result in a redirection of activity. One firm contacted for this study added a service which involved a number of departments within the firm as well as EDP. The important consideration is that the change was announced a month before a scheduled installation of a 360. The service change, due to contract obligations, took precedence over the planned conversion activity. The timing was critical for the data processing aspect of the service, and EDP work had to be prepared for the new computer. The result was that a complex system had to be prepared for a new computer and new laguages in a short time period, a time period which had been scheduled for formal training sessions.[70]

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[69] Ibid.: Case 20.

[70] Ibid.: Case 5.

Organization Change. A major change in overall company organization can affect a conversion in process as much as, if not more than, the significant service change just illustrated. Three of the firms investigated announced mergers just before new computers were to be installed.[71] In each case the announcement and ensuing activity meant conversion preparation had to be delayed. Top priority was given to changing data processing activities of one company to match those of the other. At the same time the changes had to be made compatible with legal requirements and with the new computer system. A great deal of importance was placed on converting the other company's EDP functions. Many of the conversion activities had to be delayed a considerable length of time while others had to be hastily done in order to install the equipment and to fulfill merger requirements. In one of these cases, the new computer actually came as a result of the conversion. The company was in the feasibility study stage, contemplating a conversion in more than a year's time. The merger was announced along with plans to bring in the other firm's 360. The data processing department was put in a position of having to make the two firms' processing methods compatible and to eliminate the second generation as soon as possible. The multiple changeovers were greatly complicated by the fact that all of both firms' data processing staffs quit their jobs during the more settled stages of the merger.[72]

Obviously, the resulting EDP work in the merger situations was not under the control of the EDP departments. The inconvenient timing, from the standpoint of the conversion to the 360, lead to hasty work and

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[71] Ibid.: Cases 3, 17, 20.

[72] Ibid.: Case 20.

inadequate training. It took considerably longer to get all the operations running smoothly on the new computer. On the other hand, the timing of the merger may have been beneficial to the entire company, making the EDP complications somewhat irrelevant to the total picture.

While growth does not necessarily change an organization, it does enlarge that organization; therefore, rapid company growth is rightly presented in this section on organizational change. In a particular case, the very rapid corporate growth experienced had not been estimated by the company's management or the data processing people. The growth occurred during the conversion process. Because it had not been adequately anticipated, many aspects of the planned conversion had to be delayed for continuous new needs. A great many more developmental systems were required than had been considered during the planning and early stages of the conversion.

Support of the Conversion. In any action involving a large portion of a company, the support of all the people is a requisite to success. Conversions, especially those including systems redesign, are no exception. Three types of situations were revealed by the firms contacted with regard to support of the conversion project: managerial decisions involving the entire project; managerial decisions involving only the computer and EDP; and overall support. A key factor to keep in mind is that total support occurs more quickly and completely when developed from the top down.

Management-Conversion Decisions. In three cases top level managerial decisions initated the feaibility and conversion efforts. This situation is not necessarily normal for second to third generation

conversions, because the existing EDP department is closest to its needs related to company requirements and future plans. In two situations where the management decided to undertake conversions, they were in part initiating computer activity. One company, after processing first generation materials in-house, dissolved their computer department and went with a service bureau for their conversion to second generation. Growth and increasing demands for more sophisticated systems lead them to believe that they should bring the operations back in-house and convert to third-generation equipment.[73] In the other case, corporate management decided that some form of centralized data processing facilities were necessary, and the ultimate conversion came from that decision.[74] A more unusual situation occurred when the management of one firm made a deliberate reversal of policy, and initiated a company-wide philosophy of "exploiting EDP for business gain." The philosophy was singular among the firms in this study. The ultimate result was that an extensive conversion, including thinking, applications, and computer equipment was undertaken.[75] In all these cases, the management of the firms participated in and actively supported the entire conversion effort. Their support initiated similar support from all levels within the firms.

Management-EDP Decisions. In a number of cases top management made decisions which directly affected the conversion as far as data processing personnel were concerned. These decisions were limited to the EDP realm, including such things as computer configuration, staffing, and

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[73] Ibid.: Case 13.

[74] Ibid.: Case 28.

[75] Ibid.: Case 2.

the basic approach to conversion. The decisions were rightly theirs to make. The point stressed here is their effect upon the ultimate conversion.

Two data processing managers indicated that the configuration of equipment and systems actually ordered was selected by a mangement committee. In one case, the equipment was close to that recommended in the feasibility study, and was adequate for the firm's data processing needs.[76] The other situation did not work out as favorably. The equipment and operating system were not recommended in the feasibility study and were proven inadequate for the tasks at hand shortly after installation. Within a year different and additional peripheral devices were acquired and the operating system was changed. The changes meant that most of the work had to be redone to incorporate the new features, which at the same time were features appropriate to the firm's original needs.[77]

Although staffing for the conversion generally was not a problem related to company policy, in one case it was. Between 1965 and mid-1969, there were not enough adequately trained personnel in any of the technical areas of 360 operation to go around; mere lack of help was the problem for most users. One firm was required to hire EDP staff members without any experience because of the salaries offered. Once these people had any experience at all, they were able to locate better paying jobs without much difficulty. The salary policy of the firm increased the difficulty of locating experienced personnel and keeping those they did train.[78]

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[76] Ibid.: Case 14.

[77] Ibid.: Case 25.

[78] Ibid.: Case 25.

The conversion approaches employed in two situations were changed due to management decision. In both cases the basic approach had been to use the compatibility feature and change to native mode when there was time. The managers realized that there would never be time to make the changeover without outside pressure, and asked that all operations be in native mode as soon as possible.[79] These decisions ultimately resulted in more efficient overall data processing activity. For one firm, the decision resulted in a great deal of work in a short period of time. As the managers became involved in the conversion they added more and more support to the project. Consultant programmers contracted for some of the work. The users were made aware of the high-level approval of the process and thus were encouraged to support the conversion efforts as well.

Overall Support. Support for the conversion came from all levels in four other examples. In three of the cases it was by extensive design. The fourth user, however, indicated that change within the firm had been accepted at all levels when change was initiated by the data processing department. The data processing manager felt a history of success had contributed to the position which his department enjoyed. The type of acceptance which had developed provided a favorable atmosphere for conversions as well as any other changes made.[80]

As mentioned, the other firms which experienced support throughout the firm during the conversion did so through design. Two firms were involved in national conversions. The vastness of the projects meant that

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[79] Ibid.: Cases 8, 12.

[80] Ibid.: Case 1.

well coordinated activity was a must. In these cases the parent organization worked closely with the local organization on a department to department basis, and the local EDP department worked with all of the local user departments. Communication, training, and timing were planned with great care to insure a proper company-wide attitude which would result in a successful conversion throughout the firm.[81] A completely local conversion involved the same degree of communication, training, and timing. A steering committee representing the officers of the firm initiated thinking and action for the conversion which ultimately reorganized the company around the functions of the major system implemented as a part of the conversion.[82]

Summary

While the central characters in the conversion process are members of the EDP staff, the importance of the manufacturer's representatives and the rest of the user firm cannot be ignored. The manufacturer's representatives played a part in 97 per cent of the conversion situations investigated as an element of support. The ultimate success of the conversion can rest on acceptance by the rest of the employees in the firm.

Training for the conversion project is directed in two ways: toward the general needs of the firm and toward the technical needs of the EDP staff. General orientation sessions may be all that is needed for the majority of those outside the EDP department, although users who have systems undergoing extensive change in relation to the conversion require considerably more than orientation. Over a third of the firms

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[81] Ibid.: Cases 10, 24.

[82] Ibid.: Case 23.

ignored the importance of the users during their conversions and did nothing to prepare them for operations on the new computer. At the other extreme, some of the firms took pains to include the users thoroughly on all levels from planning stages through testing, implementation, and post-implementation activities and included written documents for the users. The technical side of the training picture was primarily directed toward the data processing managers and programming and systems personnel. All these people had at least some training in a formal sense, mostly through the classes sponsored by the manufacturer. Although the experience factor is important to the use of any computer, only a few of the users considered the on-the-job training aspect in their overall conversion plans. Less than 15 percent of the users had multi-faceted training programs which included formal standards, manufacturer classes, various in-house training devices, and on-the-job provisions for all members of the firm. Specific training programs for other members of the EDP department were generally not mentioned, very limited, or haphazard. Especially in the case of operator training, the need was noticed after the fact rather than adequately anticipated before installation and use of the new computer.

A number of changes were made within the EDP department to help the conversion effort, to better operations for the use of the 360, or both. The most frequent change, either on a temporary or a permanent basis, was that of separating the programming staff into groups for conversion projects only and for maintenance functions. A successful scheme for conversions involving considerable redesign was the use of temporary conversion or implementation teams set up to coordinate activities of

the users and EDP. The software or operating system specialist came into the picture with conversion for some of the users, although more did not recognize the need until they had considerable experience with the new computer. The other changes which were made in the organization of the data processing department during conversion were more attributable to growth than to conversion itself: additional levels of management and creation of control groups.

The role of the company as a whole cannot be overlooked, because it did drastically affect a number of the conversions investigated. Major changes in organization or products and services during the conversion, altered the priorities of the EDP operations, and resulted in considerably less than the required attention being given to either event. The double conversion situations required considerably longer to resolve the operations than either would have needed separately. Managerial decisions were found, in some cases, to have been the impetus to the entire conversion or to have set the conversion pattern for others. Active participation by the managements of four of the firms resulted in total support for the project throughout the firms.

CHAPTER VI

THE CONVERSION PLAN, IMPLEMENTATION, AND EVALUATION

Having investigated the numerous aspects of the computer system, the firm's applications, and the people involved in the conversion project, it is now necessary to see how all of these elements interrelate. Ideally, the conversion plan formally coordinates and integrates the events as directed toward the final objective of a completed conversion. The acts of implementing and evaluating the conversion should flow from the design of the plan.

This chapter will include the roles of planning, implementing, and evaluating in relation to the conversion project. Applicable elements from management theory and other conversion literature will be combined with the users' actions to develop these topics.

The Plan

In order to fully understand the role of the conversion plan, there must be a basic understanding of the general role of planning. Thus, it will be possible to investigate conversion planning aspects which have appeared in data processing literature. The background provided by these two areas will help in viewing the planning action actually taken during second to third generation conversion projects.

Planning in General

The idea of planning is to set out the activities required to meet an objective. A clearly stated objective provides a firm foundation for the plan. The conversion objectives found to be employed by the users in this study were primarily operative, meaning that the action required was to complete a specific project. For most of the users, getting old programs to run on the new computer faster, through emulation or rewriting, met their conversion objective. Some of the users, however, had more administrative conversion goals and employed longer run planning procedures. Included among these users are those who intended their conversions to include major redesign of their entire data processing setups.

Longer-run plans are broken into short-run plans leading to completion of the overall project. The short-run plan becomes a detailed breakdown of part of the longer-run plan. In either case critical factors must be taken into account, and alternative actions determined for each factor leading to completion of the objective at hand. For both types of plan there are established principles showing the requisites and the elements of good plans in general.

The requisites of a good plan include a clearly-stated objective, a logical, simple statement of the plan, bases for control, and flexibility and stability. A plan must be complete and integrated. Importance of flexibility and stability in relation to the conversion plan must be stressed. Data processing concepts, equipment, and techniques change so rapidly that flexibility is of utmost concern. The new features must be constantly evaluated in relation to the firm's immediate and ultimate data processing goals, and must be adapted into the plan where fitting

and necessary. At the same time, the plan must provide for sufficient stability so that the objectives will in fact be reached.

The plan needs to set forth the objective to be accomplished, various measures of that accomplishment, guides to completing the objective, timing and phasing of the project, manpower specifications, and accountability. In relation to the conversion project, a good plan needs a formal statement of the goal of that project. Measures such as the number of programs to be changed over, the time to be allowed per program, and some error factor may be included in the initial statement of the plan to show how work during and after the conversion will be evaluated and controlled. Formal schedules indicating target completion dates further control and guide the project. Technical and operations standards serve as guides to completion of the project. The data processing personnel must be allocated to conversion projects and day to day operations. An adequate staff must be prepared, i.e., there must be enough people for the tasks and they must be able to perform those tasks. Finally, each person involved must know for what and to whom he is responsible.

The requisites and elements of good plans in general imply a good deal of formality for the plan. In other words, in order to include all features correctly, a written plan is required. Once formulated, the plan must be updated throughout the project to take into account changes and unanticipated events affecting completion. A good plan increases the chances of success.

Conversion Planning

Conversion planning is tied directly to the general principles

of planning. B. M. Baker emphasizes the great importance of planning the conversion project: "A plan that is formally developed and documented before it is begun, and updated as necessary changes arise, has the greatest likelihood of success and the least likelihood of causing restarts or rework. . . ."[1] The idea of "documenting" the work involved in moving from the present system to the new one, is essential, but frequently overlooked.[2] The plan should include answers to basic questions as well as a workable schedule. The basic questions and schedule are discussed in the following section.

Basics Covered. Robert J. Van Ness has presented relatively more material concerning plans for computer conversions than have others; however, as the others contributing in the area are doing, most of his discussions relate to general preparations for a computer. He breaks down the pre-installation effort into three types of preparation phases: work preparation, conversion preparation, and site preparation. The use of the term "conversion preparation" relates to part of the work in the conversion of applications in the context of this study. Within planning for work preparation, Van Ness says that consideration must be given to selection and training of personnel, scheduling and control, systems and programming personnel output, testing and debugging, and the work-in-process reports. His conversion preparation phase includes file conversions, cut-off dates for current operations, documentations procedures, notifying all people involved, and written instructions and procedures for use during the changeover and in the new operating environment. Site

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[1]"Economic Considerations of Conversion," p. 34.

[2]Van Ness, Data Processing with Computers, p. 203.

preparations activities should cover space requirements, location aspects, construction costs, air conditioning and humidity controls, electrical requirements, sound proofing, dust control, flooring, fire and water damage protection, tape vaults and off-site storage.[3]

The next closest discussion of plans for conversion is one by Charles Lecht which was designed in consideration of installing an initial computer. The things which he includes as elements of the plan, however, are applicable to conversions from one computer to another: systematic breakdown to the specification level of all activities to be performed; staffing pattern needed; facilities for the staff, other support personnel, the computer and software; target dates; and a flow of the entire project as a network.[4]

The Schedule. Again, there is not a great deal of literature on the scheduling of conversion projects. Van Ness has made some general observations especially related to the applications phase of the conversion. There are also some fairly specific scheduling guides for the facilities part of the change-over.

Applications. The conversion schedule must include consideration of a number of underlying facts according to Van Ness. He asks:

> What conversion method is to be used?
>
> How complete are the programming and testing phases?
>
> How many and how complex are the applications to be converted?
>
> How complex and time-consuming will the file conversion be?[5]

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[3]Van Ness, Data Processing with Computers, pp. 175-83.

[4]Lecht, Computer Programming Projects, pp. 204-207.

[5]Van Ness, Data Processing with Computers, p. 201.

He continues to stress the importance of carefully examining the applications so that they will be converted in the proper order. In other words, some programs and applications are dependent on others and cannot be changed over before the independent applications. Each application must be investigated to determine the conversion method, where it fits in the overall schedule, the specific procedures for it, the supporting activities required as file conversion and form changes, and cut-off dates for operation under the previous basis.[6] Van Ness comes close to presenting an actual time table, in suggesting that the conversion project will take about eleven months from preparation through initial changeover of applications.

Facilities. A model time table for site preparation was developed by David Roach Pierson. His pre-installation countdown is set up for six months and is based entirely on the delivery date. The theoretical ideal situation is illustrated through his time table.[7] The specifics within a pre-installation schedule are going to vary considerably according to what is already available and to what the specific equipment requires.

Only two of the firms interviewed had limited lead times in which to prepare for their new computers.[8] The rest of the users devoted as much time to planning layouts and requirements as to the construction work involved. Planning stages for one firm began twelve months before the expected delivery date.[9] For most firms, however, the planning

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[6]Van Ness, Data Processing with Computers, p. 204.

[7]David Roach Pierson, "The ABC of Installation," Data and Control, Vol.III, No. 9, September, 1965, pp. 28-32.

[8]Appendix II: Cases 14 and 20 allowed three months before installation.

[9]Ibid.: Case 7.

and construction stages of site preparation took six months. Completion of the work ranged from two months prior to installation up to the delivery date. One company purposely chose to put in the raised floor during the last day before delivery to avoid excessive operations interruption.[10]

Actual Plans

Although many aspects of the plans employed by the users have already been presented, nothing has yet been said regarding the actual planning phase of the conversion project. General features of the plans will be investigated in this section which covers objectives as they relate to the development of conversion plans, the time frame of the plan, and the types of plans used.

Objectives and the Plan. The conversion objectives of the users fell into three basic categories; hardware oriented, a combination of hardware and software, and software oriented. The categories are very broad and do not lend themselves readily to clear-cut plans. The broad objectives resulted in vague plans for the majority of users. However, some of the users did use experiences during the feasibility study or general conversion preparation to refine their conversion goals. These users combine their experience, information from manufacturer manuals and representatives, and information from other people in the field and published material to cement their objectives for the conversion and to provide firm direction in developing a workable plan.[11]

Time Frame. Knowledge of the duration of the conversion plan gives insight into two important factors. The first concerns adequacy

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[10] Ibid.: Case 25.

[11] Ibid.: Cases 2, 10, 24, 28; Cases 7, 23, 24; Cases 13, 17.

of the planned time as compared to the time actually taken or the range of the plan. The second indicates what time period was used in relation to that which was available to the conversion project before installation.

Short or Long Range. The idea of short- and long-range plans comes into play in the consideration of the planned conversion time and the time actually taken. Short-range plans cover a time span of a year and one half. Nearly forty per cent of the users had conversion plans which were well within the limits of short-range plans. It is reasonable to expect the users planning compatibility operations continuously would have short-run conversion plans. Yet one of the three of them had a long-range plan. Many of the users who had short-range plans actually completed their conversion within a short time span, but not necessarily at the intended time.[12] Three of them have since made reconversions to improve efficiency and eliminate emulation operations.[13] The others have spent at least a year longer than they planned to spend on their conversion projects.[14] The important aspect illustrated is that only a few of the users really had a short-range conversion period project. The bulk of the concentrated activity may have occurred during a short-range time; however, the entire project took a period of years.

There were two groups of users who initiated long-range conversion plans; one group had no specified time limit on the ultimate completion, and the other set a target completion date. The firms who had no target date for completing their conversion activity did get things

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[12] Ibid.: Cases 4, 5, 7, 9, 14, 15, 20, 21.

[13] Ibid.: Cases 4, 14, 21.

[14] Ibid.: Cases 1, 3, 8, 11.

operating under emulation fairly readily, but chose to rewrite and redesign "as there was time." Two and one-half years after installation, most of these users are still looking for the time.[15] One of these firms set up positive schedules to complete the redesign and the rewriting efforts needed to get all their systems operating in native mode.[16] Only one user completed the changeover without a target date.[17] The users who set long-range target dates have either completed their projects or are still working within the time limits projected.[18] All have set more precise short-range schedules within the overall plan. They have adapted resources, training, etc., to meet specific needs and to help assure that the target date for completion would be met. Only one firm greatly exceeded the expected time of completion.[19] The rest, who have completed the projects, did so within approximately six months of the target date. The point is that the users who established target completion dates have finished changing their programs over, while the majority of those doing the work "as there is time" still have systems to change over.

Pre-Installation Time. Use of the time available before installation of the computer is a definite indicator of forethought and action given to the conversion project. It also shows where more direct action can be taken to prepare for the conversion, in the cases which used only

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[15] Ibid.: Cases 6, 13, 17, 19.

[16] Ibid.: Case 16.

[17] Ibid.: Case 18 completed the changeover 18 months after installation.

[18] Ibid.: Cases 2, 7, 10, 12, 22, 23, 24, 25, 26, 27, 28.

[19] Ibid.: Case 27 took 4½ years rather than the planned 2 years.

a fraction of the time available. For anyone beginning use of the 360, the normal waiting period was from two years to eighteen months before, or rather, between, order and delivery. Later, the necessary waiting time was reduced to as little as seven or eight months. Order-delivery lag at the beginning was mainly determined by the manufacturer's delivery schedule, although the user could ask for a later delivery than specified. All but four of the users investigated had waiting periods of a year or more. Two of these were exceptional cases with only three months preceding installation and will not be considered further in this phase of the analysis.[20] One other group of four users cannot be considered because it was impossible to determine just when they began their conversion activities.[21] However, two of them probably used more than the useable lead time to prepare for the new computer.[22]

The time the users actually spent on their conversion projects ranged all the way from one month to greater than three years. It is important to note three major groups within that very wide range. About a quarter of the users devoted less than the last 30 per cent of the time they had between order and installation to conversion projects.[23] In other words, if there was a twelve months' lead before installation, the users spent time on conversion work during the last 3 or 4 months at the most. This includes all planning and work done. A third of the users considered here spent the last 50 to 75 percent of their lead time on

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[20] Ibid.: Cases 14, 20.

[21] Ibid.: Cases 15, 16, 22, 23.

[22] Ibid.: Cases 22, 23.

[23] Ibid.: Cases 3, 5, 11, 21, 27.

conversion projects.[24] The remaining users indicated that they spent at least the last 90 per cent of the lead time on conversion efforts.[25] The most significant part of this last group are the seven users who, in fact, devoted more than the lead time to their conversion.[26] The users in this group are important, because they indicated that they were actively pursuing conversion planning and preparations before the machine had been ordered; some began before machine studies were even made. All users in this group planned to use emulation as an intermediate step only.

Type of Plan. The type of plan indicates the amount of time, thought, and importance given to the project by those directly responsible for it. Formality of the plan, the basis of the schedule, special techniques used, updating the plan, and retention of the plan show factors concerning the type of conversion plan used.

Formality. Formality of the conversion plan basically refers to its preparation and presentation. A written plan based on procedures, schedules, guides and controls is considered to be a formal plan. The plan or parts of it would be distributed to those who had a part in the conversion. A semiformal plan is one in which major elements are written or formally scheduled, but most of its contents are not written. An informal plan is at the opposite end of the scale. Primarily, it is developed, distributed, and updated verbally, if at all, with little concrete material to refer to at later times. The conversion plans developed by the users investigated for this study consisted of a fairly even number of each type of plan mentioned. The users' plan types break down

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[24] Ibid.: Cases 1, 4, 6, 7, 12, 13, 25.

[25] Ibid.: Cases 2, 7, 10, 17, 18, 19, 24, 25, 28.

[26] Ibid.: Cases 2, 7, 10, 17, 24, 25, 28.

as follows: 43% had formal plans; 25% had semi-formal plans; and 32% had informal plans. A substantial group of users had little more to go on than the "seats of their pant." Users having plans felt as though they were also stabbing in the dark, but they tried to determine where the best "stabs" would be for their situation and direct action that way.

Schedule Basis. Two major target dates serve as the basis for developing the conversion schedules. One date of significance is the delivery date for the equipment. Obviously, facilities preparations must be geared to the installation date. The required work needs to be completed before the machine is there. As mentioned before, the scheduling directed toward facilities preparation was more or less required through the coordinated efforts of manufacturer and user. The second main target date of the conversion schedule represents the time applications were to start running on the new computer. A series of target dates is possible. Reflection on various methods of conversion used, it is easy to see that a number of change-over dates were possible for a single firm's applications. If a series of change-over dates were used, some order of priority must have been established. The number of users who assigned priorities and target dates to their applications and the number who did not assign any order, or indicate an assigned order, was even. Forty-three per cent of the users arranged their applications in some priority order and assigned target dates to their completions.[27] Another 43 per cent indicated no concern with order.[28] In between these extremes were three users who set only an order of importance.[29]

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[27] Ibid.: Cases 1, 2, 7, 10, 12, 22, 23, 24, 25, 27, 28.

[28] Ibid.: Cases 3, 4, 5, 6, 8, 9, 13, 15, 16, 18, 19, 21.

[29] Ibid.: Cases 14, 17, 20.

One user who indicated the order and target dates for the first phase of the applications and file conversion, left the order of the redesign and rewriting phase up to the current needs.[30] The last user outlined only the major phases of the conversion, but set no priorities within the phases or completion dates for each phase.[31] All but one of the users employing emulation as their primary conversion method was in the group which did not set target dates or priorities. This situation may be due to the fact that they anticipated little trouble with the compatibility mode or that their entire library had to go into operation on the new equipment more or less simultaneously. There was no pattern in the types of target dates set, but it is essential to indicate the general areas which were mentioned: systems design, programming and debugging, superior testing, file conversion, old operations, cut-offs, and actual change-over of operations. An ability of many of the users to set up priorities and reasonable target dates was hampered considerably because there was inadequate documentation to serve as a basis for the process.

Indirectly included in the target date for the applications conversion, is the aspect of staffing and training. And although no one set any specific dates for staffing and training, action was taken in advance of the need. Two firms had specific employee build-up goals effective throughout the conversion process.[32] Another had contracted outside help before the projects required additional help,

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[30] Ibid.: Case 11.

[31] Ibid.: Case 26.

[32] Ibid.: Cases 18, 25.

and all this came up.[33] Regardless of the type and amount of training done for the EDP staff members, whatever was intended was completed before the staff needed to use the knowledge directly. For instance, programmers working on conversion projects completed their training before they were to start programming. Operators had at least orientation sessions before they were expected to operate the new computer. Only one firm began programmer training immediately upon ordering the equipment. In this case, there was quite a gap between the training and use of the information.[34] For those users who included personnel outside the data processing department in formal training, the training occurred immediately prior to their involvement in the project. They were trained to the degree that they were involved.

It is difficult to tell whether or not overtime was considered in the conversion schedules. Only one user admitted that a good deal of extra work hours were required from everyone from training through implementation.[35] The overtime hours were included in the conversion plan. A considerable number of extra hours of work seemed to be taken for granted as a part of the conversion. Working long, odd hours was commonplace when data center and leased time was used for testing or file conversion. The odd hours could not have been avoided. Data centers were overloaded; firms with time to lease naturally would keep prime working hours for their own needs; and file conversions frequently had to be completed over a week-end to avoid interrupting normal operations any more than necessary.

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[33] Ibid.: Case 3.

[34] Ibid.: Case 19.

[35] Ibid.: Case 11.

Special Techniques. Only a few users indicated that they employed special planning techniques. Two firms used forms of charts to derive their plans and a third used PERT scheduling. Arrow diagrams were developed by one firm to help assure that everything throughout the process was properly coordinated.[36] Another firm developed a series of task charts to handle complex file conversion and the emulation conversion desired.[37] The firm which used automated PERT scheduling had done so with all major data processing activities in the past. The object was to break all tasks into as many steps as possible, affixing both order and estimated times of completion to the steps. While the original projections were not accurate, the scheme gave vital managing direction to the entire conversion. The data processing manager suggested that even more steps would be defined for scheduling future conversions.[38]

Updating. Whether or not a plan was updated during the conversion process is important, if the plan was, in fact, used as a guide. Data processing technique changes, altered needs for applications, and changes in other areas would certainly have occurred to some degree during the scheduled conversion. Taking such changes into account is a vital part of the planning. A plan must be kept current. Updating plans is somewhat related to the formality of the plan developed in the first place. It is difficult to determine how users with informal plans updated them, because they more or less developed the plan as they went

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[36] Ibid.: Case 14.

[37] Ibid.: Case 11.

[38] Ibid.: Case 22.

along. One of the firms with an informal plan actually had a semiformal long-range plan which was indicated by a multiphase equipment order. The process time savings resulting from the conversion were much greater than expected, making the additional equipment unnecessary; yet the order was not corrected. An unnecessary machine was installed and later taken out. The users with semiformal plans had some "tangibles" which could be changed officially; however, most of them indicated that they did not update their original plans. Two of the users with semiformal plans did evaluate their plans. One found it necessary to revise the scheme and the other did not.[39] Only one of the users who had developed a formal plan indicated that there was no attempt to update or review that plan.[40] The others did review and revise their plans as their knowledge increased and as various factors changed. The firm which used PERT scheduling updated the schedule on a weekly basis and was the firm which did the most frequent formal updating.[41] Two other cases are of particular interest. One firm found it unnecessary to change its plan and schedule although reviews were held throughout the process.[42] The other case involves a firm which did not set specific target dates for completion but had a definite order of attack. But because a merger interrupted the planned conversion process, the specific steps were delayed until the merger activities were completed, and work on the conversion projects was then resumed in the planned order.[43]

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[39] Ibid.: Case 1; Case 8.

[40] Ibid.: Case 14.

[41] Ibid.: Case 22.

[42] Ibid.: Case 12.

[43] Ibid.: Case 17.

Retention. Just as documentation of a firm's applications may be used in many ways other than direct operation and maintenance of the programs, documentation of the conversion may serve additional uses in the future. Primary among the other uses would be for future conversions, whether redesign on the same computer, or to another new machine, and changes in data processing management. Needless to say, it would not be necessary or even desirous to keep all the paper work which accompanied a conversion, but a number of things might require future reference. Critical correspondence, the plan and the schedule, major adaptations to the plan and significant reasons for major changes, and notations of critical elements overlooked or given too much attention can serve future data processing operations.

In part, the amount of conversion documentation retained by a particular data processing manager is going to reflect his reliance on past records to formulate the future. Two extremes illustrate the point. One firm indicated that past experiences were of no value in a current conversion project, except perhaps the experience which was "lived" rather than recorded. The conversion plan developed was informal, and no record of it exists.[44] On the other hand, there were a number of users who relied heavily on past records. One manager had directed numerous previous conversions. The records he kept of them served along with research, manufacturer information, and outside conversion seminars as a basis for the conversion plan developed for changing from second to third generations.[45]

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[44] Ibid.: Case 26.

[45] Ibid.: Case 7.

It was impossible to determine if those with informal conversion plans kept anything at all. Only one user indicated that the correspondence with the manufacturer had been retained, although others certainly kept that information. Of the users who developed semiformal conversion plans, only two indicated that a part of the documentation was still available.[46] As might be expected, the majority of those who developed formal plans retained documentation of the conversion process.[47] Two indicated that they had kept some of the conversion documentation, while three firms indicated they did not keep any of the material.[48] In many respects it is difficult to determine exactly what was done, since only four users allowed any inspection of their conversion plans.[49] One other had critical correspondence on hand for the interview.[50] Reluctance to show this material indicates one of two things: either it was not available or the manager did not particularly care to be forced into evaluating the conversion project.

Implementation and Evaluation

Implementation and evaluation of the conversion plan are discussed together because of their relationship to each other and their combined relationship to the plan. The two together are necessary to carry out a plan. A plan must be put into action and then steps must be taken to assure that the plan is both adequate and being followed.

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[46] Ibid.: Cases 1, 21.

[47] Ibid.: Cases 2, 7, 10, 17, 22, 23, 24.

[48] Ibid.: Cases 14; 28; Cases 11, 12, 27.

[49] Ibid.: Cases 2, 7, 22, 23.

[50] Ibid.: Case 1.

Implementation of a plan may be investigated through the evaluation of what the plan is, although implementation is conducted within controls set up within the plan. Evaluation factors may also be set up within the plan.

At this point the discussion is limited to the users who had formal or semiformal conversion plans. The users who had informal plans really just implemented their conversion process as events came to them; any "plan" was rather after-the-fact. On the other hand, users who had some form of tangible conversion plan had direction to the process. When that direction was combined with target completion dates, there was a control built into the plan. A good number of these users did not indicate that any particular aspect was used to control the project.[51] Either the users represented in this group did not realize they were controlling the conversion, or they were not using even semiformal plans to directly guide the project. The most commonly used control device of the remaining users was the formal review session. Three users held weekly meetings and another held monthly meetings to review progress and adapt plans for the coming period.[52] The two firms which participated locally as a part of a company-wide conversion had numerous controls and checkpoints for progress. Controls were provided in the conversion plan, through extensive networks communications, and through the use of the in-house installation teams.[53] Three firms employed unique controls. In one, applications documentation traveled and was updated at each step. The completed "package" was reviewed between

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[51] Ibid.: Cases 8, 11, 12, 17, 19, 20, 21, 25, 26, 27.

[52] Ibid.: Cases 7, 22, 23; Case 1.

[53] Ibid.: Cases 10, 24.

steps and moved to final implementation on the new computer.[54] Another firm required dated, written approval of each task which was completed during the conversion project.[55] The last firm controlled the conversion project in two ways: technical control was possible through automatic controls built into the firm's teleprocessing scheme; programs not within bounds of the central specifications were kicked off the computer with appropriate messages. Other aspects of conversion were controlled directly by the data processing manager who traveled frequently and continuously revised standards for each remote user, techniques as well as training and staff development aspects.[56] The real point about control of the conversion is not the particular method used, but whether or not the direction provided by a plan was put into action and followed.

The act of controlling the conversion process, in turn leads to an evaluation of both the process and the plan. All users who indicated positive control measures did, in fact, review and modify their conversion plans. The information provided through control of the situation can be used either to improve the basic plan or to rearrange various resources to further insure that the project is completed as expected.

It is important to indicate the ideal of evaluation in relation to the basic conversion objectives. The objectives, again, were found to be related to hardware aspects, software aspects, or a combination of applications and hardware aspects. Not one of the users investigated goals defined objectively enough to really be measured and evaluated.

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[54] Ibid.: Case 18.

[55] Ibid.: Case 2.

[56] Ibid.: Case 28.

In other words, even those users with the most objective basic goals, those related to hardware, did not have specifics in mind. For example, if increased speed was an objective of the conversion, there were no dimensions or expectations given for that increased speed. Those users who had goals more related to software aspects of the new computer, such as the implementation of specific types of applications, would have a difficult time developing a measure for the successful completion of the task. The measure would be considerably more subjective than that of a hardware feature, but some indication of a satisfactory or acceptable performance could be developed. Because none of the users had firmly stated basic conversion objectives, it is difficult either for them, or any others, to evaluate the success of the entire conversion project which was undertaken.

Summary

A conversion plan is closely tied to the objectives, and leads to the implementation and ultimate evaluation of the conversion. The less definitive the objectives and plan, the more difficult it is to know the conversion project is moving in the intended direction and following that direction in a reasonable manner.

Of the basic objectives found for the conversion projects, the ones based on the software aspects of the computer and new applications are the most comprehensive, and involve the most time and activities. Detailed plans of a formal nature were most common among these users; however, they were not limited to them. Regardless of the objectives of the conversion, it seems to be a long-run project. Even the users who intended to run compatibility permanently found change necessary.

While many users spent more time on their conversion projects than they had planned, those which established priorities and target dates for the applications have completed their work. The users without such concrete guides either found them necessary eventually or are still looking for extra time in which to complete the work.

Although not the majority of those investigated, it is important to note the group of users who actively employed the time available to them before installation of their computer to prepare for the conversion. The users who were working toward conversion even before the order was placed developed the most comprehensive plans and standards for the project. Once an order is placed, the coming conversion is a fact, and it is not too soon to begin preparing for the change.

Carrying out the conversion activities relates back to the plan. A complete plan with target dates, standards, methods, and priorities for facilities, applications, and the people involved has built-in devices to keep the conversion on track. The devices, however, must be used and kept current in order to be of value as a guide. The users who chose just to implement the conversion are, for the most part, still without firm direction in their projects. These users had very informal plans, if any, and have no real basis for evaluating the progress or results of their conversions.

CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to describe a framework for a conversion project. Actual situations were investigated to find out what was done during conversions from second to third generation computers. The framework of the study consists of common elements found to exist within three major areas: the particular computer system, the applications involved, and the people who perform the conversion activities. A fourth area, planning, combines the elements into the proper setting for carrying out the required activities. The planning phase of a conversion is dependent upon searching out and knowing the elements in the other three areas.

Summary and Conclusions

More than twenty-five data processing managers at firms which converted from a second generation computer to an IBM/360 Model 30 or 40 in a major population center of a Southwestern state provided the information for this study. The data processing managers were asked to relate their conversion activities. The investigation was necessarily open-ended in order to cover all activities undertaken, common or unique. If certain things were not otherwise mentioned, descriptive questions were asked to discover what objectives were intended, what equipment was used,

which applications conversion methods were used, what file conversion procedures were used, what people and training were involved, what organizational changes were made, and how the conversion was implemented. The information was analyzed by analogy according to each area and on an over-all basis from the standpoint of the conversion plan.

The conversion elements found are summarized in Tables VII-XII. It is important to note that not all the elements will apply to every conversion. On the other hand, research activities cited provide for yet unknown elements.

An obvious element in the conversion is the computer system. It was found that the users evaluated the computer system more in terms of hardware features than in terms of its software capabilities. The users primarily looked at the hardware features of speed, volume, and throughput. They understood what the new machine could offer in these areas and evaluated it in terms of their second generation hardware. The majority of the users skimmed over the operating system or software aspect of the new computer system. It was definitely a new and complex feature. To many, software was not of immediate concern. The operating system, however, quickly became their chief concern.

Applications conversions primarily followed the pattern of prior generation conversions: old methods were switched to faster machines. Such a change is not necessarily the wrong one, especially when there is no current or forecasted need for a change in the method. While emulation leaves the old program exactly as it was, many rewrite and redesign efforts resulted in essentially the same methods written in a new language for a different computer environment. Emulation as a continuous operating

TABLE VII

SUMMARY OF COMPUTER SYSTEM ACTIVITY

HARDWARE ACTIVITY

Equipment: Configuration Adequacy, Long-Range Plan
Support Equipment
Supplies

Layout & Work Flow: Current Set Up
Intermediate for use with both computers
New Computer, Long-Range Plan

Site Preparations: Computer Room--Balance requirements/limits
Staff Areas--Own, Manufacturer's Reps
Storage Areas
Arrange & Schedule Necessary Work

Aids: Current Blueprints, Manuals, Manufacturer's Reps, Use of Like Machine

Key Dates: Start--Once Configuration is Known
Plans, Scheduling--6 Months Prior to Delivery
Completion--Delivery Date

SOFTWARE ACTIVITY

Decisions: Operating System(s)--Manufacturer (Supported/Not)
Other Source
Programming Languages
Emulation/Simulation--Degree; Duration
Relate to needs, applications, hardware

Research: Differences from present computer system
Emulator or Simulator restrictions vs. own requirements

Aids: Manuals; Manufacturer Schools; Other Schools; Manufacturer Reps; Publications; User Groups; Other users; Use of a Like Machine

Key Dates: Start--Before Order
Completion--Variable; Order is important

ENTIRE SYSTEM ACTIVITY

Review selected and new elements with needs periodically

TABLE VIII

SUMMARY OF APPLICATIONS ACTIVITY:
PROGRAM AND FILE ACTIVITIES

PROGRAM ACTIVITY

Decisions for each application, program:

- Conversion Method
- Order and Priority Basis
- Work and Time Requirements

Research: New software vs. applications requirements
Documentation
Production Statistics
User Needs

Key Dates: Basis--order, work and time needed, implementation plan

FILE ACTIVITY

Decisions: Method--Translator; Special Equipment; Special Programs
Timing--All at once; Application by application

Key Dates: All files at one time: Cut-off of old data
Set non-production time
Schedule extra equipment/
Special program completion
Variable, if application by application

Research: Media changes
Collating Sequence
Data Base
File Arrangement and Organization

PROGRAM AND FILE CONVERSION AIDS

- Documentation
- Operations Logs and Production Statistics
- Priority Listings
- Work Progress Listings & Checkpoints
- Manuals
- Standards

TABLE IX

SUMMARY OF APPLICATIONS ACTIVITY:
STANDARDS AND TEST ACTIVITY

STANDARDS ACTIVITY

Technical Standards: Research--New & Old Computer Systems
Objectives
Applications (Current/Intended)
Predicted Needs
Previous Standards
Intended Use of Machine

Operations Standards: Research--Data Files
Volume of Work
Planned Work Flow
Operator-Machine Intervention

Technical & Operations Standards: Form--Written
Automatic

Key Dates--Start before order
Update continuously

Documentation: Continuous activity, once initiated
Update with change

TEST ACTIVITY

Method: Dependent on conversion approach, work done, priority

Major Areas: Adaptations to supplied systems or utilities
In-house procedures programs
In-house automated controls
Applications Programs (From source to final output)
Files
Operating procedures

Aids: Activity Listing
Test data

Key Dates: Depends on--Pre-installation testing
Schedule of change-over
Completion--Error free operating cycle
Timing may be particularly critical

TABLE X

SUMMARY OF PERSONNEL ACTIVITY

Staffing

- Analyze: Positions Required--New
  - Altered
  - Eliminated
- Staff Requirements--Increase/Decrease
  - Temporary/Permanent
  - Sources of New Personnel
- Assigning Conversion Responsibilities

Training

- Decisions: Who is involved--EDP Personnel
  - Others in the Firm
- When are they involved
- How are they involved

- Levels of Training: Technical
- User Involvement
- Orientation

- Training Devices: Formal--Manufacturer Schools
  - In-House Programs
  - Outside Programs
  - Programmed Instruction
- Seminars--Supplementing On-The-Job Training
  - Special Topics
  - Orientation
  - User or Professional Groups
- On-the-Job Training
- Use of Intermediate Machine
- Test Activities
- General Research
- Guided Participation

- Materials: Manuals--Manufacturer
  - Standards and Procedures
- Tip Sheets
- Publications

- Key Dates: Depend on time of involvement
- Continuous for new features and review

TABLE XI

SUMMARY OF ORGANIZATION ACTIVITY

EDP ORGANIZATION ACTIVITY

Creation of Special Work Groups: Programming Teams
Training
Implementation or Conversion Team Coordinating User-EDP

Research: Growth and Conversion Activity for--New EDP Sections
New EDP Activities
New Levels of Management
Organization Concept

Key Dates: Add/Change staff before need
General Organization/Management as soon as possible

COMPANY-WIDE ORGANIZATION ACTIVITY

Research: Long-Range Company Plans
Long-Range User Department Plans

Develop Support Among: Managerial Personnel
User Personnel
EDP Staff
Others

Key Dates: Concentrate Activity--During Feasibility & Planning
Prior to Involvement
Continuous process requiring periodic review

TABLE XII

SUMMARY OF PLAN, IMPLEMENTATION
AND EVALUATION ACTIVITY

OBJECTIVES

Research and Balance: Computer System--Hardware Selected
Software Selected
Applications--Current Type/Volume
Projected Direction
Long- and Short-Range
Each Major Activity
Measures of Completion

Key Dates: May begin before feasibility
Solidify following order

PLANS

For Each Activity: Evaluate and isolate work elements
Set--Order
Priorities
Target Dates
Controls
Assign Responsibilities
Distribute parts of plan and schedule to those involved at proper time

Key Dates: Begin once objectives are set
Continuous activity through final evaluation

Aids: Research Each Main Activity (as Tables VII - XI)
Planning Techniques--Manual
Automated
Previous Conversion Documentation

IMPLEMENTATION & EVALUATION

Critical Factors: Control Elements and Enforcement
Periodic Reviews
Plan Updating

Review & Control Techniques: Automatic--Run Time; Volume
Formal--Documents
Work Approval
Meetings

Reanalyze: Implementation Activity, Plan, Objectives, Changes

basis appears to be the wrong long run policy. Even though the particular cases investigated could emulate jobs faster than they would run on the old equipment, the most efficient operation is still native mode. A staffing problem related to emulation can develop after the fact, especially in fields stressing current and future activities. Programmers, operators and even systems designers do not want to work with outdated features, so trained personnel become difficult to obtain. Automatic translators appear to be of little, if any, value as an applications conversion aid. Clear cut standards were generally lacking. Those firms which developed and maintained standards for the conversion and future operations stressed the key role which they played in the entire process. They served both as a control feature and a training device. Likewise, second generation documentation was generally inadequate or missing, adding to the complexities of the conversions. Steps have been taken to ease this problem in the future by most of the firms.

Training or retraining the people involved in conversion received more attention than did other aspects of staffing. Only increases in personnel were noted. The needs were anticipated and met in time for some training. A position that was not generally filled--one for which many found a need following installation--was that of a systems operator or software technician: the title varies greatly, but the duties are tied to technicalities of the operating system. With a new computer system hiring trained people is not possible for those who convert shortly after the computer becomes available. Technical training of the data processing staff is therefore a necessity. Programmers received the great majority of the training, and much of it was completed at the manufacturer's

education center. There was a limited use of on-the-job training intentionally spelled out by the user's conversion plan, and still fewer combined on-the-job with semiformal help sessions or seminars. On-the-job training is not meant to be a sink-or-swim situation, but conscious efforts must be made in order to use the information learned in the practical situations.

Operators generally were more overlooked in the training process than were users. At most operator training was limited to very short sessions just prior to use of the computer. The vital role of the operator has received more attention in the long-run. Steps have been taken by a number of users to make sure operators understand the equipment, the operating system messages, and their job.

Inclusion of users within the firm and various other personnel to the proper degree helps get their cooperation and understanding when it is needed. Certainly everyone does not need detailed information about the conversion. The firms making comprehensive changes in their data processing operations found it desirable at least to orient indirectly involved personnel; some users received even more formal training through classes, standards manuals, and participation. On the other hand, some user firms seemed to have purposely avoided letting outsiders in on anything. One important advantage in informing users of a pending change is that they may be more willing to put off changes they need until the newer version is ready. Support and communication throughout the firm is important to conversion, especially when changes or errors occur. Cooperation is certainly better than apathy or antagonism.

Organizational factors were important in two places: within the

data processing department and in major company policy decisions. The most frequent EDP change made was to establish two working groups of programmers. One group handled conversion projects while the other worked strictly on maintenance and day-to-day problems. This arrangement occurred regardless of the primary method of applications conversion. The most frequently cited advantage was that some of the people were freed from day-to-day work and were able to concentrate their efforts on the conversion. Major changes within the firm as a whole were found to be almost catastrophic. The untimely upheaval which a merger can cause really cannot be avoided unless later plans include the merger, or the entire conversion is postponed.

Plans are based on objectives. Because the greater part of the users did not appear to have clear and precise objectives, the plan and the control and evaluation which arose from it were not complete and thorough. Similarly, the projects were long-range efforts, although they evolved and were not planned that way for some. It appears that conversion for most users is not a short-range project. A good deal of work is concentrated immediately before and after installation of the computer, but the entire conversion takes place over considerably more time. While the firms which developed integrated schedules for their conversion did not necessarily meet the original target dates, they had guides to direct them to an ultimate completion of the project. Much of the initial planning and scheduling can occur in advance of the equipment. Standards, allocation of resources, and various phases of pre-installation work can be researched and founded during the time span between an order and the delivery.

It is interesting to note that there was only a minimal use of the tools normally associated with data processing and systems analysis. While systems analysis techniques are generally applied to applications for the computer, the known techniques were not applied to a very major data processing project. The facilities preparations and file conversions appeared to be more precisely thought out and executed on time than were the applications and training activities. One reason for this may be the relatively greater objectivity of the factors to consider in readying a facility or in converting a file than in the other two areas. Perhaps the personnel involved had a clearer understanding of exactly what had to be done in these areas. Completion of the facilities to meet minimum conditions set by the manufacturer before installation also contributed to the seemingly more expedient work in that area.

Certainly the dynamics of data processing as a whole is an important force, meaning that a firm's situation must constantly be under observation so that a proper direction is being followed for the firm's needs. It also means that plan and schedule updating are essential. The study indicated that plan and schedule updating were not generally formal or comprehensive in relating needs and capabilities once the order was placed.

Again, it must be pointed out that the idea of this study was not to see that the original plan and the actual procedures were exactly the same, but to see that a guide existed and was used to steer the conversion project. The observations of several conversions were more important than the conclusions. The conclusions presented must be viewed subject to the limitations of the study and in relation to the suggestions for

further research to refine the steps in the conversion project. The study has only covered the surface of a vast area.

Suggestions for Additional Research

The literature directly related to conversion to a non-compatible computer is scattered and not particularly comprehensive in any single source. The vastness of the area has been particularly brought to light with the third generation equipment. Never before had so many changed to a new computer at one time. The increasing use of computers indicates that even more extensive change-overs may occur in the future. The market for used computers, primarily second generation machines, indicates that conversions from second to third generation computers will continue to take place, although probably at a slower pace. The combination of these factors suggests that more research is necessary before anything like a theory of conversion can be developed. This study uncovered areas where additional research seems merited.

The data processing managers surveyed all represented conversions from second generation computers, mostly IBM-1401's, to IBM/360 Models 30 and 40. While representative, these users are by no means inclusive of other third generation conversions to other 360 Models or to other manufacturer's machines. By studying larger and smaller users as well as users of the other manufacturers' equipment, the elements considered in conversion may be somewhat increased. The emphasis may also be found to be different. The generalities made in this study must be considered in relation to the specific sample taken.

A variation of the study may be useful to determine just when conversions start and stop. Conversion may, in fact, be found to be a

continuous state--more or less an evolution within data processing. Research and planning to direct conversion would therefore be necessary all the time. The idea of perpetual conversion would indicate even more strongly the need for long range planning to provide stability to the change and to prevent the change from becoming an uncontrollable cancer.

Another area which requires more understanding is related to applications. There is no measure of the complexity of a particular application which makes scheduling people and the project particularly difficult. The present method for evaluating the time a particular application will require is an educated guess at best. It must be remembered that even programs intended to be run under compatibility frequently required some changing for the conversion. Thus evaluation is even necessary for emulation changeovers.

The interrelationships of the elements of the conversion project are as yet unclear, except a comprehensive objective and plan provide a necessary guide. Research of larger samples coupled with statistical methods would seem to be a logical extension of this study. Future research should also include larger samples representing divergent geographical areas, equipment manufacturers, and sizes of equipment.

Recommendations for Data Processing Management

Identifying the elements of a conversion project may mean that data processing managers will have a more solid foundation for planning and carrying out conversions from one computer to another in the future. The elements noted can be used for a solid starting point. However, they cannot be accepted as final: a conversion to the next generation will likely involve new features and require new thinking. The elements cited must be combined with research to develop a workable plan.

The data processing manager must look into what is truly new. The new computer's features must be related to the current and projected data processing environment and needs. The total picture must be considered, broken into pieces, and put back together in the form of definite objectives and plans. It will take research to uncover and find out what the new features really mean in light of the firm's data processing operations. It is erroneous to assume that evaluation in light of past experience alone is adequate.

The data processing manager will need to ask how the differences relate to what he has, and then to what he needs. The questions will cover: facilities; resources such as people and supplies; current and projected applications; and projections of the firm's needs. The questions must not only cover the present and the future, but the intermediate stage, too. A five-year prediction of anticipated needs is advantageous, even though it may not be accurate.

The answers to these questions can become the basis for reasonable and clear objectives, a long-run plan, and founding standards. A detailed short-run plan can be developed along with standards and controls. Evaluation of the entire framework must be continuous to see that the right path is being followed. Such evaluation can, in fact, lead to basic changes in the plan, standards and controls, and in some circumstances even the objectives. New equipment and techniques need to be considered in the evaluations as well as the plan and actual implementation.

It is not too soon to begin setting down conversion objectives, plans, standards, and controls during the feasibility study. Once the order has been placed, the time before installation can be used to finish

preparations as well as to begin conversion activities. Putting all the preparatory efforts off until close to installation is certainly too late.

The plans must integrate activities concerning the new computer system, the applications, and all the people involved. Each must be considered in respect to the total picture to determine the exact activities necessary to meet the objectives. The appropriate conversion approach for each application may be different, requiring different levels of participation from EDP staff members, user department personnel, and all others in the firm. Adequate training or orientation steps need to be considered and developed to meet the conversion.

Most important, the data processing manager will need to realize that he cannot get entirely wrapped up in day-to-day activities and merely implement the conversion. He will have to make time to step back to plan and continuously evaluate the conversion, and to keep current production maintenance in a proper perspective. Without a guide, conversion can become multidirected and out of proportion. With a guide, even a perpetual state of conversion moves in a direction consistent with the firm's needs and the appropriate state of the art in data processing.

Support for the conversion must be nurtured outside the data processing department. Participation and training to the proper degree can help obtain such support from management on down through the organization. The time and effort can pay off at critical moments when there is a need for understanding on the part of a particular party. Ignoring "outsiders" can only lead to resentment and antagonism in the long run.

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APPENDIX I

GLOSSARY

APPLICATION.--The system or problem for which a computer is used. Frequently associated with commercial functions such as payroll, inventory or PERT systems. Also used to differentiate software into two groups: applications and internal systems.

ASSEMBLY LANGUAGE.--The low level programming language. Not easily readable. Provides greater flexibility and use of the computer's capabilities.

BACKGROUND PROGRAM.--A program which fills the processing gaps between demands by a foreground or on-line program. Subject to interrupt and delay. Subordinate to a program of prime priority or to process requests from terminals.

BASIC OPERATING SYSTEM (BOS).--Least sophisticated of the 360 operating systems, offering only essential and fundamental options. A disk-resident system. Teleprocessing and multiprogramming facilities not available. Requires minimal core.

BATCH PROCESSING.--A computer operations and processing approach. Grouped input items processed during the same machine run. A processing convention for accumulating and submitting data as a unit for efficient computer operation.

CENTRAL PROCESSING UNIT.--The component of the computer hardware. Calculates and performs logic decisions based on man-made programs of operating instructions. Circuits of the computer system for arithmetic, logic, and control.

CHANNEL.--Component of a computer system which allows simultaneous operation of the input/output devices (card reader-punch, tape drive, etc.) and the main computer. An independent computer, controlling input/output units via channel commands.

CLOSED SHOP.--A computer room operating environment. Strictly enforced when no one but the operating staff is allowed in the computer room.

COBOL.--Acronym for Common Business Oriented Language. A high level language. Can be written in a form to be read by the layman and to be self-documented. Not necessarily readable or self-documenting.

COMPATIBLE.--Computers consistent with one another. A "family" of computers all of whose members can execute the same programs, within certain limits, without program modifications. In pure form, any program written for one computer which can run on the other without change.

COMPATIBILITY OPERATING SYSTEM.--(COS). The 1967 compatibility feature. Allows continuous operation of emulation and native mode jobs. Previously necessary to halt operations and bring in the operating system needed for a particular run. Permits automatic means for rolling in and out of the native operating system thereby increasing the processing time available.

COMPATIBILITY MODE.--Also emulation mode. Use of compatibility features. A combination of circuitry and software allowing the computer to read and run programs written for other computer systems.

COMPILE, COMPILER, COMPILATION.--To convert a high level source program into a machine language routine. A program or set of programs which perform the conversion. Processing that leads to the conversion from a source program to an object program.

CONSOLE.--A hardware unit used for communication between operator and computer. Lights, keys, switches, etc., for manual control of the computer.

CONVERSION.--All activities directed toward changing from one computer to another, including the physical change of equipment, applications change over, training, and scheduling.

CORE or CORE STORAGE.--A form of magnetic storage permitting access to information within the computer. Limits the scope of the activities which may be performed with the computer.

CUSTOMER ENGINEER (CE).--An IBM designation for the person who installs data processing equipment, gets it running, and maintains it. Responsible for maintaining programs such as compilers, operating systems, and peripheral control programs.

DEBUG.--To test or examine a program in order to find and correct all errors and mistakes. May pertain to locating computer malfunctions.

DISK or DISC.--Storage device which uses surfaces of one or more disks for magnetic data recording. Provide input/output access to the computer.

DISK OPERATING SYSTEM (DOS).--Disk-resident 360 operating system which lies between BOS and OS in sophistication. Allows teleprocessing and multiprogramming. Provides maximum throughput, a control program, five programming languages, and other features.

EAM.--Electrical Accounting Machines. Punch card or unit record equipment, distinct from data processing equipment. Includes key punches, sorters, reproducers, and accounting machines.

EDP.--Electric Data Processing.

EMULATION.--Process permitting one computer to be set up to execute programs written for another (non-compatible) computer. A combination of hardware and software packages which allows use of "old" programs and input and produces the same output as the old computer, within some constraints on storage, input/output devices, etc.

FILE.--An organized collection of data.

FORTRAN.--FORmula TRANslating system. A high level programming language resembling algebraic notation. A standard scientific data processing language.

FOREGROUND PROGRAM.--A program initiated by outside requests delaying a background program. Takes precedence over a background program.

GENERAL PURPOSE COMPUTER.--A computer designed to operate on more than one program of instructions for the purpose of solving many types of computational problems rather than being designed to fulfill a single purpose. Often thought of as having capability of performing both scientific and commercial applications.

GENERATION.--Grouping of computer equipment distinguished by certain hardware characteristics from another group. Historically a new generation has appeared every five to seven years. Through 1970, three computer generations have been used.

HIGH LEVEL LANGUAGE.--Programming languages such as COBOL, FORTRAN, and RPG. Relatively easier to learn and use than low level languages.

Require translation to the computer's machine language through the use of a compiler. Not necessarily standard between different computer manufacturers.

HARDWARE.--The mechanical, magnetic, electrical, and electronic devices of a computer system. Physical equipment.

INPUT/OUTPUT (I/O).--Source data and data produced during a computer run. May be devices from which data is read, or on which data is written.

LANGUAGE.--Combination of vocabulary and rules of syntax.

MULTIPROCESSING.--Processing on a machine with multiple CPU's and main storage units that can be used simultaneously on more than one problem.

MULTIPROGRAMMING.--A technique of letting two or more independent programs share a computer facility during the same time interval. Use of processing delays in one program to process segments of another.

NATIVE MODE.--Technically, operation of the computer under the most micro level of programming possible for that machine. In this study, any program operating on the machine that was written or compiled on or for that computer. Programs run on internal software native to the computer.

OPEN SHOP.--An environment in which programmers operate computers, generally for check-out and testing purposes. Loosely, a computer room open to any EDP staff member.

OPERATING SYSTEM (GENERAL).--An integrated collection of computer instructions. Handles selection, movement, and processing of programs and data needed. Basically, control and processing programs.

OPERATING SYSTEM (OS)/360.--The most sophisticated and powerful of the 360

operating systems. Disk-resident. Requires the most core storage of any of the operating systems. Provides the greatest flexibility, number of options, and use of hardware.

PERIPHERAL EQUIPMENT.--Hardware units that work in conjunction with the computer, but not under control of the central processing unit.

PERT.--Program Evaluation and Review Technique.

PL/1.--Programming Language/1. A high level programming language. Takes advantage of the best features found in COBOL and FORTRAN. An IBM language, not available on other third generation computers.

PI COURSES.--Programmed Instruction Courses. Specific series of PI COURSES for 360 operating systems, programming languages, etc., which are self-teach media.

PROGRAM.--The plan and operating instructions needed to produce results from a computer.

RECODE.--Manual translation of a program from one language to another. The same existing and resulting programs, in different languages.

REDESIGN.--Substantially changing an existing system or systems from the design phase through implementation. May result in a system quite similar to the existing one or may result in a system unrecognizable in terms of the first. Requires analysis, design, programming, check-out, testing, and implementation steps.

REWRITE.--A conversion method which lies between recode and redesign. Minor changes to the existing program or system. System logic or concept is unchanged. Likely limited to programming efficiency changes.

RPG.--Report Program Generator or Report Generator. A special purpose high level language permitting production of a report from

descriptions of the input file and report format.

RUN.--May be termed PASS. One execution of a program or common set of programs on the computer. Involves a complete sequence of processing on one set of input data, requiring little or no operation intervention once the job is set up.

SIMULATION.--A strictly software feature allowing one computer to imitate the software of another. Significantly less efficient than emulation or native mode operation.

SOFTWARE.--Limited to internal systems in this study. May be all man-written instructions needed to solve problems with the computer including: (1) internal systems such as compilers, operating systems, emulators; (2) applications programs which are run on the set of hardware and internal systems; (3) documents such as manuals, flow charts, program listings needed to guide operation of the computer. May be highly integrated with the hardware, and, therefore, difficult to separate from it.

SYSTEM.--An organized whole. The combination of hardware and internal software as the computer system or System/360. A set of programs designed to process the work in some particular area, as the inventory control system.

SYSTEMS ENGINEER (SE).--An IBM specialist who helps develop capability and skill in applying data processing techniques and helps get the user's systems running efficiently and effectively. Assists in areas of system design, installation, applications development, and operating procedures.

SYSTEM GENERATION.--Process of tailoring a comprehensive operating system

package to meet individual configuration situations and needs. Requires eliminating all but that which is essential to free unnecessarily used core. Must occur when any part of the hardware or software configuration changes, or to initiate the use of an updated system release. Also called "sys gen."

TAPE.--Usually a magnetically coated ribbon on which information may be placed in the form of magnetically polarized spots. Information storage media used and created through tape drives which are linked to the computer.

TAPE OEPRATING SYSTEM (TOS).--A 360 operating system between BOS and OS having the same capabilities as DOS, except teleprocessing.

TELEPROCESSING (TP).--A term registered by IBM which designates systems that transmit data from one point to another in the course of processing.

TERMINAL.--An input/output device connected to the computer system, capable of sending and receiving information to and from the computer. Usually located some distance from the computer. Connected to the computer by some medium such as direct wire, telephone, or teletype.

TRANSLATE.--To change from one language to another without significantly affecting the meaning.

UNIT RECORD EQUIPMENT.--Electromechanical machines used to process data recorded on punched cards. May be used as input/output devices connected to an electronic stored-program computer.

UNBUNDLING.--Term applied to separation of hardware and software costs. A pricing policy announced in mid-1969 by IBM. Has forced users to decide whether they want to sign software contracts to maintain the

IBM expertise and help in this area or develop internal software specialists. Did not affect this study. Must be considered in future conversion projects.

USER.--In this study, a firm which has a computer, or a department or person within a firm who uses information processed on the computer.

APPENDIX II

CONVERSION CASE STUDIES

The case studies investigated to provide the data for this study are presented in this section. They have been divided according to industry, because of some peculiarities which exist. While the firms investigated do have many data processing similarities which allowed them to be considered together for the study, the unique elements among industries gave rise to the groupings.

Banking Cases

Savings and demand deposit accounting are the founding applications in bank data processing operatings. The volume of data flowing through these applications daily is particularly exceptional. The special training institutes held for bank personnel are also singular. One held yearly on a national basis is for bank data processing. The institute provides an outstanding example of user knowledge sharing.

The banks investigated in this study all were processing centers for other banks. As processing banks they handled the data management activity for other banks in demand deposit and savings account recording. The banks also applied the computer to numerous uses for their own use only.

Case 1

Bank 1 has enjoyed a fairly unique position among computer users. The size of its staff has not changed in seven years. Furthermore, turnover within the EDP had been nonexistent. The staff's continuity plays an important role in the conversion of the bank's in-house software and will be discussed more fully later.

Two 1401 disk systems were installed by the bank in 1962. From the beginning the two machines were operating three shifts daily. The high utilization factor plus management's realization that data processing was here to stay made it desirable to investigate alternate equipment. Two equipment studies included various lease and/or buy considerations. Prime emphasis was placed on improved throughput, better printers, faster sorters, and improved magnetic ink readers for check processing. Costs were evaluated in terms of hardware, i.e., volume of processing per time unit.

Because alternative equipment had been considered for some time, the bank was ready to place an order to buy 360 equipment two days following its formal announcement. It did not intend to get the first machines off the assembly line. The equipment met the processing and financial requirements set previously and was needed in time. The two phase order was met when a Model 30 was installed in August, 1966, and Model 40 in February, 1967. In other words, the bank had more than two years to prepare for the use of its third generation computer equipment.

Within six months of the order, basic decisions were made concerning the approach to be taken with in-house software. Two factors were involved: (1) to obtain the manufacturer-supplied compatibility feature; (2) to rework all applications systems. The compatibility

feature was obtained to use while completing the reprogramming effort, but it actually was used longer and relied upon more heavily than had been anticipated. The decision to redesign and reprogram all 1401 applications was based on a philosophy that there is a five-year cycle to systems--i.e., systems should be reviewed and updated every five years. It was felt all systems would gain from redesign and reprogramming.

Software conversion work was developed under the project manager philosophy. Priorities were assigned to the old systems. Then two programmer analysts were assigned to the project. The one who had considerable prior experience with the system was designated project manager, taking advantage of the long term employee continuity. He knew the program design and those who used the output. The other programmer member of the team was selected for his unfamilarity with the system. Because the project had not been his since inception, fresh and objective approaches were anticipated. The second advantage of the unfamiliar programmer was in exposing yet another person to detailed knowledge of the system. Care was taken to work with the user department, if only during monthly progress meetings. This followed concentrated redesign sessions at the beginning of the system conversion project. Direct inclusion of the user resulted in a significant side benefit. Users realized the change was underway, so they did not ask current maintenance that wasn't absolutely necessary. Greatly reduced current maintenance work was a considerable advantage. Programmers frequently become so tied to current operations and maintenance that they devote only minimal time to new or conversion projects. The user involvement in the bank's software conversion efforts eased and essentially eliminated the normal problems of

resistance to change. Through the user involvement, orientation, and education to the converted, "new" system was both continuous and gradual.

Programmers were sent to the formal, manufacturer orientation and training schools a few at a time. They were able to begin the programming work for the new equipment as they returned. Two major systems, installment loans and bookkeeping, were begun nine months prior to receiving the first machine. Programming efforts were also directed toward implementing a manufacturer designed banking application package and toward the use of teleprocessing facilities with the new equipment. The necessity of on-the-job training was recognized. There was a basic willingness to take the time necessary to learn to use new features and equipment. A case in point is the bank's early work with teleprocessing. Considerable learning time was included in plans for the project.

Completion deadlines for the various projects were developed by the data-processing manager and project manager. In essence, the dates were comfortable targets. The "comfort" factor resulted from the detailed knowledge the project leaders already had concerning the systems and from the compatability feature allowing the old systems to be run basically as they were on the new equipment. The data processing manager emphatically noted they would have been "dead" without compatibility. The compatibility feature was invaluable to the bank's conversion process, not because its target completion dates were slipped (they weren't), but because the first machine installed was plagued with mechanical difficulties. The machine was ultimately completely replaced.

The mechanical difficulties also made introducing the new teleprocessing application difficult. The T.P. system could not be used unless the machine was in operation. Excessive down time meant that users

were frequently frustrated by not being able to obtain the specified information.

All of the original 1401 systems, the initial teleprocessing application, and the package adaptation were completely operational twenty-one months after the installation of the first machine. The mechanical trouble with the first machine and the difference in sophistication between the Model 30 and the Model 40 led to unexpected delays for the data processing department. The bank was basically unprepared for the differences found between the two models. The problem was traced to the operating systems which were common, yet different, to each. While frustrating, the delays were not extremely critical. The "comfortable" target dates were met anyway. Conversion projects were completed in an environment of good company communications. Many meetings and informal discussions provided mutual understanding. Formal, written communications appeared only when minute forms directions were necessary. Monthly meetings served both as education and project control devices.

No changes were made to the physical area for the machines. There was no additional space available. The old equipment was moved into an adjacent hall for operation during the initial change-over. New equipment layouts and planned placement were adjusted to the existing space.

Machine operation became a problem area for the bank. There was no operator training from the standpoint of a good school or on an in-house basis. The increased operator dependency upon the console had not been adequately considered prior to installation and during early operation of the equipment. As a result more internal standards for the operators have been developed.

The bank, in general, had data processing standards commensurate with others using 1400 series equipment. There was little, if any, formal documentation of any form of data processing standards. Employee continuity eased the problems which normally exist under such situations. However, the need for more formalized standards was recognized, and they have been developed for and with the use of the third generation equipment. Concentrated effort has been in systems documentation and operations standards.

Another feature which evolved is the operating system specialist. The bank's "expert" in the area of the operating system became important after the initial use of the equipment.

Conversion efforts not limited to the data processing department were made less difficult through the internal history of data processing. Change in the bank comes from the data processing department. Many of the problems associated with change are overridden by a trust which has developed toward data processing. The trust is attributable to top management and the systems which have been put into operation. Most other departments within the bank are so completely engrossed in day-to-day activities that they cannot take time to consider change. The data processing department, on the other hand, takes the time to think through changes and to work them out with the appropriate users.

Case 2

Expanded business objectives provided the key to the second bank's conversion. Excessive growth, a growing market, and emphasis on employee education were integral factors of the approach. It became top level managerial policy to exploit EDP for business gain. The data

processing manager emphasized such exploitation as a healthy business approach; it provides the foundation for a sound conversion scheme. The underlying philosophy was that managers, not the data processing department, define the business' needs. Within the framework, changes and new systems are other manager's ideas; the plan developed is theirs, not the data processing manager's. At the same time the data processing manager recognized the need to take time to involve himself in the planning process.

Directly relating to the data processing operations, the new business approach was responsible for eliminating earlier decisions and steps which had proven unsatisfactory. The new approach also allowed a framework for profiting from earlier mistakes specifically involving conversion. The bank underwent a conversion to what the data processing manager terms "two-and-a-half generation"--an intermediate machine. The conversion was relatively rapid, fourteen months from programing through completion. The goal was to reduce hardware costs as quickly as possible, as opposed to the idea of using the power of the new equipment. To accomplish the rapid cost reduction, a one-for-one recoding approach was taken. In other words, the "old" programs were manually translated into a new language for the machine on which they were to operate. At the same time, the hardware emulation feature was used allowing the previous machine's programs to be run as they were on the new equipment. The data processing manager felt this was an undesirable approach, but it was the only one until the overall objectives of the bank were changed.

When the objectives changed, so did the bank's data processing needs. Conversion to a Model 40 was undergone, because the system was

very close to the bank's total data processing requirements. Almost four years after installing "2-1/2-G" a 360/40 arrived at the bank. To accomodate the new machine under the new business philosophy, there were numerous other changes encompassing facilities, software conversion plan and user involvement, organization, EDP training and standards, and user training.

Manufacturer installation specialists and the bank's own staff of internal technical advisors were consulted in relation to facilities requirements for the new equipment. Specifications for BTU's, space, air conditioning, etc., were noted. The internal technical advisors were responsible for completing the necessary work prior to receipt of the equipment. While six months were allowed and found adequate for the facilities work, the data processing manager would allow a year for similar work in the future.

A four year software conversion plan was developed. The plan was to resystematize all programs in their portfolio at the time of the decision to install the 360. All systems designed following the decision were to be developed for the 360. Two phases went into the plan for each individual system's redevelopment. The first phase involved definition of the user's need. The analysis included the user himself, his services, and a general overview of costs involved. The second phase of each resystematization concentrated on what was best for the bank as a whole. The general cost review of the first phase was expanded to include all resource requirements for the project. At this point there was a Project Review setting out the plan developed for the system to users and data processing personnel involved. The user's written approval was required for each step during planning.

Information from the resystematization plans for the four-year conversion was used to develop a much more precise Action Plan. The Action Plan is a formal document covering one year to eighteen months of activity involving education, change, and personal objectives. The four year software conversion is still in process, so the total effect of the individual Action Plans is not known. The first Action Plan was developed in detail three months prior to the installation date of the Mod 40. A large binder contains formal statements of the objectives, standards for each group, time phasing for each group, the resources required, and applicable historical records of the projects. The objectives cover a wide range of areas from education and training to specific project completion information. Each system to be converted was charted to show the time required during conversion to "2-1/2-G," the IBM SE's estimate, the percent completion estimated by the end of the current Action Plan, and the target conversion date. The Action Plan is a working document. Changes are made to it, and it is used to evaluate progress and possible changes. The formal Action Plan described is unique to the bank's data processing department and has not been developed out of company-wide policy.

Communications processes and user involvement are paramount under the exploit-EDP-for-business-gain philosophy of the bank. The importance was noted by user involvement in the planning phase. It was further recognized in a basic reorganization of the data processing department. The change in philosophy dictated the new equipment; the philosophy plus the multiprocessing environment of the equipment dictated data processing departmental changes. The old EDP organization was along functional lines with one programmer assigned to each area. The new organization was based

upon maintenance, programming, and systems teams, not limited to one project or area.

Under the previous equipment environments work was done in a single operation per system mode. Third-generation equipment forced a change indicating needs to schedule resources, think in terms of job streams, and control input-output operations. The I/O control group was added to the department as a distinct function. A technical support group was formed within the EDP organization nine months after installation of the machine.

Employee education was an important feature of the new company philosophy and comes to light in relation to the 360 conversion. Training had been continuous since it was begun, nine months preceeding installation. The EDP education program included operators, programmers, and systems analysts. Training geared specifically toward conversion concentrated on the operating system (full OS) and MVT, with a number of workshops held on OS. By coming into 360/40 use four years after the System 360 was announced, the bank wisely profited from the difficulties others experienced in learning to use the operating system. The original prediction of total training indicated the procedure would take a year to eighteen months. To the EDP department, total training meant the use of its own formal procedures, the use of applicable outside facilities not limited to manufacturer sponsored schools, on-the-job training, and investigation of what other users were doing. Training for conversion was concentrated and thorough for a specific purpose. The pattern developed has served continuously since then and is used to present new features and ideas as well as to refresh employees' memories. The

Technical Group within the data processing department is now responsible for the primary, formal education efforts. Video equipment is available and used extensively for training all EDP personnel.

While there were some formal EDP standards with the use of second generation equipment, it was nothing like the two volumes of standards which have emerged with the 360. The manual was originally a concentrated project of the Standards Committee. The committee was formed from members of each of the following groups: Systems and Programming, Operations and Production, and Technical. The committee has operated on a continuous basis from inception to update the original manual. An important feature of the manual appears on page one in the first paragraph: a statement of how the manual is to be used, how it will be enforced, and how it can be updated.

User training is the last main area which was affected in the conversion process. User training was accomplished externally and internally. Various people were selected according to their functions from all levels within the bank to attend outside training sessions. The outside sessions were basically courses from the manufacturer Executive Management Courses. All internal user training occurred after the equipment was ordered. Some was directed to help immediately with user involvement in the resystematization planning. Other training involved post-installation orientation. The bulk of the user training occurred when it was vital in the program planned to complete the specific software conversion project.

Case 3

Merger activities and a general lack of personnel preparedness

characterized the conversion Bank 3 experienced. These two factors combined in complicating and extending the time required for change from second to third generation computer equipment.

The bank under study merged with another bank just prior to the expected installation date of the new computer equipment. All of the accounts and bookkeeping procedures of the second bank had to be made compatible with the primary bank's processing requirements. The data processing functions of the second bank were to be added at the time of the primary bank's conversion. As the second bank had had no data processing staff, the personnel of the primary bank were heavily tied up in the work of converting records, methods and procedures to accommodate the merger. Simultaneously, the new machine preparations were being made.

A data processing manager was hired two months prior to installation of the new equipment. Activities for the 1440 system were handled by three programmers and three operators, through the accounting department. Some conversion details had been scheduled by others before the data processing manager arrived. Four major factors preceeded his arrival; (1) the merger decision was finalized, although there were no data processing preparations made; (2) outside help was contracted; (3) two of the three programmers attended various manufacturer sponsored schools; and (4) a new computer room was constructed in accordance with manufacturer specifications. The first two factors definitely confused the situation. Work directed toward the merger was top priority. The contracted help proved incapable, and was released after four costly days.

As the complications of the machine conversion and the merger became more apparent, the necessity of a single data processing manager

was noticed. No one on an appropriate level had any understanding of the specific data processing problems involved. A data processing manager who was familiar with neither the System/360 nor any level of conversion was hired. He had only two months to prepare himself and his staff for the new computer.

The plan developed to carry out the conversion process was based upon urgency criteria. The following four phases were mentally set out as the guide: (1) ability to operate the 360; (2) completion of merger activities related to data processing prior to receiving the equipment; (3) emulation of 1440 operations; (4) redesign and rewrite for all systems over a two and one-half year span. The merger activities were a must. There was no alternative to their being completed on time. They took up the great majority of the time preceeding installation of the new equipment. Some minor preparations for emulation on the 360, mod 30 (print line changes allowing the new printer to react correctly to line and page changes) were completed before the data processing manager arrived.

Once the machine was installed, three weeks of generating and testing the compatability operating system was completed before releasing the 1440 equipment. Outside facilities were located to convert the data files from 1440 disk to 360 compatible tape and then to 360 disk. The bank's 1440 had only disk storage. The disk data was not directly transferrable to 360 disk or character format. The data processing manager was primarily responsible for the generation and testing phases. During initial use of the computer the operators were being trained on the job by the head operator who had been to an introductory course.

The emulation feature, while not pre-tested by the bank, essentially allowed concentration on the merger activities prior to installation. Once the new equipment was operating smoothly under compatibility mode, redesign and new project activities were begun. It was estimated redesign and new projects then considered would require two and one-half years. Many of the systems to be added were purchased packages which required alteration to meet the bank's requirements. The systems were implemented one at a time as they were completed. All new applications required training outside the data processing department, especially in areas as new balancing techniques and new or changed forms. A particularly time consuming effort was an original underestimation of data editing or checking for feasibility. In early 360 applications, rigid editing was not included. The burden of proof of error was found to be with the data processing department. Program changes were made and more rigid automated checking was included in later work and was only one of many learning factors involved.

The data processing manager estimated that the entire first year of operation with the equipment was a learning process. In addition to learning detailed requirements for users within the bank, much time was devoted to understanding the machine, operating system, and programming language technicalities.

During the early use of the new equipment, there was considerable turnover among the data processing staff. In the first two and one-half years of operation, the staff of five programmers had seen a dozen different faces. Some left for better opportunity; others were fired for lack of quality output. The same situation occurred among the operators employed.

The turnover and over-all ineptness at using the new machine meant the individual system conversion deadlines were missed many times. Parallel runs had to be 100 per cent accurate before the emulated systems were replaced with native 360 versions. Many of the systems originally emulated operate that way yet, three years following installation. Current demands for new systems and maintenance increasingly delay the completion of the fourth phase of the data processing manager's original conversion scheme.

In evaluating the bank's conversion, even though it is as yet incomplete according to the initial, undocumented plan, the data processing manager characterizes it as chaotic and haphazard. He stressed two areas in which he would have changed his approach: (1) knowledge of the operating system, and (2) advance standards. By the end of 1967 there were some people who had fairly detailed understandings of the operating system, its peculiarities, and how to use it advantageously. Knowing what he knows now, the data processing manager would have looked for experienced help on the operating system area to include in his staff from the onset. He would also allow six to eight months in advance of installation for the development of standards. Programming techniques would be formally written up before they were to be used.

Case 4

Bank 4 learned a great deal which could have been applied to its conversion plan. The learning, however, took place during conversion and early use of its 360, Model 30. The increased sophistication and power of the third generation equipment had not been fully anticipated and considered prior to conversion. Concern was not with the total

effect, but with individual pieces--a fact which will become apparent as the evolution of data processing in Bank 4 is explored.

Data processing operations in the bank began in 1962 with unit record systems on IBM 407 and 604 equipment. The volume of data increased rapidly, and a conversion was necessary to a 1401 disk system within two years. The most voluminous application involved demand deposit processing. The processing philosophy used with the 1401 was to allow a single data file per disk pack. Each new program required a different pack. The only input source was punched cards. All processing occurred via disk as the 1401 system used had no tapes. Programs were processed individually. The bank's library of programs was not large, and all data processing personnel knew everything about all of them. However, none of their collective knowledge was recorded as documentation.

Increased volume and processing needs again provided the rationale for changing from the 1401 to the Mod 30. Processing speed was the main consideration. The 360 was to be used as a big, fast 1401. The conversion plan was, therefore, based on emulation. The Compatibility Operating System allowed operation of the 1401 programs at slightly faster speeds, providing the bank's main requisite. The demand deposit programs needed to be redone at the time. Work on them began eight months before installation following Assembly Language and operating system schools. The work involved took all of the remaining time before installation.

Efforts were simultaneously going on in other areas related to the conversion, although most work immediately preceeded and followed installation. The weekend before the 360 was to arrive, the 1401 was moved

into a temporary area where it was retained for thirty rent-free days. A corner of the computer room was set up for the use of the C.E.'s. Only minor adjustments were required before the new equipment arrived. Two weeks were allowed before operations were to be entirely on the new equipment. During the initial two weeks the equipment was activity centered on control card development, testing, and operator training. Creating the control cards necessary to run the 1401 jobs under the Compatibility Operating System began before the new equipment was installed. However, the jobs were not tested until the new machine was installed. Last minute changes were required for both the programs and the control cards. The last minute rush was hectic, but the data processing manager asserted that COS made the "conversion a snap." Testing was also done on the newly recreated demand deposit programs. Only limited data center test time had been available for program debug phases. A majority of the immediate test time was devoted to making demand deposit outputs compatible with programs run under COS using that information. The aspect of "old" and "new" system interaction had been underrated. The combined effect of testing requirements resulted in time scheduling difficulties. Test time was rushed, partly because testing on the 360 was expected to be easier than on the 1401. Such was not the case. The 1401 programs were single elements. With the 360, series of programs and stacked jobs were employed. (The change also meant moving from a single data file per pack philosophy to one of multiple files.) The great interaction involved had not been fully contemplated. Likewise, the role of the computer operator had been viewed in terms of the 1401. Operator training was on-the-job and only very basic.

The attitude that the 360 was a big, fast 1401 did not allow adequate training of operators for use of the 360. This was realized suddenly, about two years following installation. Currently a program is under way to teach operators many "whys" of 360 operations. One portion of the program is provided through an operations school directed toward the operating system used by the bank. Correcting inadequate use, the 360 involved both hardware and software aspects. The major hardware change involved the addition of tape units to the 360 system. While slightly increasing processing times resulted from the 1401-360 change, the original systems were excessively I/O bound. Disk processing of the bank's data was very fast. The input was still directly through cards, and card-reader speed is, at best, considerably slower than the processing speed the bank used. By adding tape units and changing the processing scheme from card-disk-card or print-out to tape-disk-tape, the I/O processing gap was significantly reduced. This is but one aspect of the third generation's sophistication for which the bank was not prepared. In the software area, the sophistication of the equipment and operating system lead to different systems planning considerations. The emphasis turned to careful plans for system flow and file organization as opposed to the old individual event idea. It was found that systems planning time doubled for 360 applications.

Increased sophistication also led to changes in the approach to documentation. As mentioned, no formal records existed describing the 1401 programs. Written system documentation, production schedules, and programming goals are now standard. The job interaction which developed and personnel turnover both led to requirements of formal documentation of systems. An over-all attempt to develop a more professional total

data processing department also led to formal scheduling for operations time. Formal goals have been developed for systems and programming personnel. The goals cover thirty-day, sixty-day, six-month, one-year, and five-year time periods.

Since it was decided that the bank was not "using" its 360, two other changes have occurred. The basic programming language is now COBOL, and not the originally accepted assembly language. The programs run under the compatibility operating system were placed on a conversion schedule. It is estimated that the complete redesign and programming of the old programs will take two years. In part, the redesign and programming effort is to obtain advantages provided by the 360. The other factor involved is the vastly decreasing number of programmers willing or capable of working with 1401 programming languages.

The data processing manager notes that the increased power of the 360 was not adequately anticipated. The sophistication factor had been almost completely overlooked in the original conversion. With the knowledge and experience gained during three years of use, the concern is now with the total effect and interaction of systems and data. A main side effect has been that change to applications now takes considerably longer.

Case 5

A decision to become the area sponsor of a national credit card system coincided with and shaped the conversion experienced by Bank 5. The urgency of meeting the credit card's central processing requirements dictated the direction of effort through the conversion. Use of the new equipment and implementation of the credit card system came about

simultaneously. To gain insight into the conversion plan and actual conversion experience of the bank, the environment provided by the previous equipment and applications must be understood.

The bank's own credit card system took all of the available run time on one of the bank's two second-generation computers. Three-quarters of the monthly run time on the disk based 1440 was devoted to that one application. The balance of the 1440 time and all the time on a 1401 tape system was used for normal banking applications such as demand deposit, savings account, and installment loan accounting as well as a payroll system for bank employees. Possibilities of obtaining the services of a bigger, faster computer were investigated to handle increasing volumes of data.

Eighteen months after System 360 was announced the bank ordered a Mod 30 with both disk and tape peripherals. Seven-track tape drives were ordered providing compatibility with the 1401. Normal 360 drives have 9 tracks, and are not compatible with second generation equipment. The system was to be delivered two years later. At order time the idea was to obtain the compatibility feature for the Mod 30 allowing overload programs from the 1401 to be run on the 360. All 1440 applications would be gradually reworked for the 360. The 1440 would be released, and the 1401 would be retained indefinitely. Supporting the decision was the small size of the programming staff and heavy day-to-day work and maintenance commitments. Little was done prior to installation of the new equipment. Training efforts were concentrated after installation as the first four months of 360 use were devoted completely to programming use. Priority 1440 systems were redesigned and coded, although there was no real pressure completion date. The compatibility feature and total

use of the machine by programmers at the onset reduced the pressure normally associated with conversion efforts. No formal schedule was presented. Six months before delivery the bank decided to change to a new credit card system. In the process it undertook new data processing responsibilities. The next months were devoted to working out inter-bank problems. Data processing people were not included in the negotiations. Official notification of the change did not come to the data processing department until a month before delivery. General specifications and a completion date allowing two months of work accompanied the official notification.

The announcement meant that all of the effort of systems and programming personnel were directed toward completing the new credit card system within two months--the two months either side of the installation date of the new equipment. The only systems analyst and two of the three programmers attended basic 360 schools early in December. Programming for the application began as soon as they completed the schools. Fortunately, only minor changes were needed relative to the bank's own credit card application, and a basic recode approach was possible. However, inexperienced people using a new language were in a rushed programming situation. The unwritten schedule called for four weeks of programming and three weeks of testing after installation of the machine. The entire department and one outside programmer spent all of this time on the system.

A new computer room was designed and constructed specifically for the Mod 30. The design and plan was approved by the manufacturer representatives, and the room was completed three weeks before the equipment arrived. Faulty tape drives complicated the initial debugging

and testing efforts, and required replacement. Seven-track drives, not specifically designed for long term use on a 360 system, were replaced with nine-track drives. The replacement eliminated the mechanical difficulties which accompanied the conversion and meant there was no tape compatibility between the old and new equipment. Both inexperience and mechanical problems resulted in a one month delay in implementing the new credit card application.

Two areas other than the credit card system received attention just prior to implementation. Data from the bank's own credit card system had to be readied for the new system. Changes to the format and basic storage device were necessary. It was not possible to get the old data directly from the 1440 disk onto the 360 disk. It was necessary to go to an outside source to create tapes with the 1440 data and then to recreate the records in the proper format for the new system. While no major retraining of people outside the data processing department was necessary, there were some format changes involved with input and output. Key punch workers were notified and tested to produce cards in a new format. Those who received reports were alerted as to the changes they should expect. Computer operator training was limited to on-the-job sessions under the direction of an IBM S.E.

Implementation of the credit card system did not complete the originally planned conversion. The programmers had all machine time other than that required for production runs of the new system. The next step was to prepare the remaining 1440-based programs for the 360. As the plan was to let programming have the use of the machine until the systems were operational, the 1440 was retained considerably longer than anticipated. The change over to 360 operations, including 1401

overload processing under COS, was completed eight months following installation of the equipment. Day-to-day problems overshadowed direct software conversion efforts. The emphasis did not allow sufficient time for adequately training programmers.

Data processing operations are primarily on a day-to-day basis, although the picture is currently changing somewhat. The history of operating only a day at a time also lead to relatively insignificant formal planning of the conversion process. Since the initial effort, many people have been added to the staff, and an additional, larger computer has been obtained. The 1401 programs were placed on a priority listing to be redesigned over an unspecified time. Programming efforts two and one-half years following installation are still primarily concerned with the 1401 programs used at that time.

Marketing Area Cases

The marketing area firms were most concerned with specific types of applications. Pricing and billing applications were of prime interest to a few of the firms. Growth had greatly increased the volume of data processed and resulted in critical timing problems. Other marketing area firms were more interested in inventory control and transportation problems in dynamic situations. All the marketing area firms included normal data processing applications.

Case 6

The pressure of day-to-day work and increasing demands to develop new systems played major roles in the conversion process experienced by Wholesaler 1. These factors were so influential and

prevalent that serious evaluation of the conversion results was not attempted until well after installation. An evaluation-action program was initiated two and one-half years after installation of a small Mod 30 and indicated that action took precedence over plan during the conversion efforts.

Work load and volume had increased on the 1440 previously used to the point at which additional capacity was needed. A 360, Model 30, replaced the 1440 and provided the power desired. It was decided that the slightly increased speed provided through emulation would be adequate. The main intent was to run 1440 jobs as they were on the 360; any programming changes to native mode were to come as time was available after the equipment change had taken place and the new equipment had been proven satisfactory.

The 360 replaced the 1440, in both physical and software senses. No changes were made to the physical location of the machine. The old one was moved out for the new. Operators learned essentials of making the new equipment act as though it were the old. Programmer training for this initial action was not necessary. It became so only as rewrite efforts were started after installation and successful operation of the emulator was apparent. At that time programmers attended basic system classes and a language school.

The pressure was on day-to-day activity. New systems also took precedence over rewrite efforts. When there was time, recode was the main approach taken to changing the 1440 programs to native mode 360 ones. Redesign was minor, and was avoided unless there was reason to improve the operation. A fair amount of attention was given to correcting an oversight in the previous conversion from unit records to the 1440.

Accurate input was assumed. Only the most necessary edits were added to the 1440 programs as the need arose. Recoding and redesigning for the 360 provided an opportunity to include accurate and systematic checks. Not all of the original 1440 programs have yet been changed to 360 mode operations. No one has felt any pressure to change them, especially as emulation has been sufficient for the needs.

When redesign was deemed necessary, the programmer worked directly with the user. User information was essentially unchanged. The programmer-user interaction provided the means of training for those changes which were incorporated. The entire process was informal.

Memory capacity was quadrupled, and peripheral devices were changed and added since the original installation. Many of the changes were due to increased processing demands and the increased scope of systems designed for computer use. These changes, made well after the initial installation, caused growth-based changes for the data processing department. Formal organization was changed from a single EDP manager to separate heads of programming (systems included), operations, and key punch--each reporting to the data processing manager. Two employees were added to perform data control tasks including I/O logging and tape library maintenance. Increased use of the 360 and increased data processing activity in time led to increased quantity and quality of data processing personnel. It also resulted in an appreciation of the systems approach and the realization that projects take much time to complete accurately.

The day-to-day and new development pressures decreased somewhat two years following installation. As mentioned, the evaluation which took place at that time resulted in attention being directed toward

system and program documentation. None had previously existed. Developing feasible documentation for all operating systems is now in process. It has been noticed that over-all accuracy has improved now that documentation and other corrective actions have been completed.

The basic approach of Wholesaler 1's conversion was to do as little tampering as possible with the old systems, programs, and ways of doing things. Continued data processing growth following installation of the original 360 led to a substantially changed computer configuration and numerous other changes affecting organization of the EDP department, systems and programming techniques, and methods of operation. Generally the growth has meant increasing formality for total EDP operations.

Case 7

Weekly status updates served as the control mechanism which supported the conversion schedule for Wholesaler 2. Progress was charted on a modified bar-chart device. The progress was then compared to the pre-planned target dates. The conversion plan followed was based on the firm's experience in data processing.

The company had more than four years of experience with computers before ordering third generation equipment. Its unit record equipment was replaced with a 1401 in 1960. As the company and general data processing volume grew, the configuration changed and systems were added. At one point, time was leased through a service company to develop and operate a complex system for product pricing and customer billing. The system was too big for the company's equipment but did not immediately justify additional in-house equipment. Increasing volume and critical

timing problems made it apparent that the system would have to be an in-house one. The 360 was ordered to allow adequate processing time for the system and for all of the in-house 1401 systems. The Compatability Operating System was obtained primarily for the 1401 programs, because the new equipment was justified by bringing the one system back in-house.

Conversion planning began right after the order was placed, more than two years in advance of installation. Training, the pricing and billing system, data center test time, and COS were given primary attention. As an overview, two additional programmers were hired and the entire staff received formal manufacturer training. A separate conversion group of programmers was established while the others remained on duty for day-to-day needs. All of the pricing and billing system programs required redesign and recoding. Because the system had been done by a service company, the redesign was a bit complicated. Listings of the programs used were released to the company, but minimal documentation accompanied the package. The company felt that big blocks of test time would be required for the pricing and billing system. The "blocks" of time they had in mind were not available through the data center. This factor had to be considered in planning and setting target dates. The Compatibility Operating System served as the basis for running the 1401 programs which were in-house. Considerable attention was directed toward adapting COS to meet the specific 1401 situation of the firm. The main headings of the specific conversion schedule developed appear in the following table.

The detailed schedules provided direction for the overlapping functions to be performed and coordination toward successful completion

CONVERSION

Area of Concern	Person Responsible	Total Time	Start Time	Complete Date	Status
1. Systems Design					
2. Programmer Education					
Conversion Group		24 Mo.	9/65	9/66	
Others		25	9/65	12/66	
3. Software Selection					
Primary Language (COBOL)		2-1/2 Mo.	2/66	4/66	
Secondary Language (RPG)			2/66	4/66	
4. Plan for data files		3-1/2 Mo.	3/66	6/66	
5. List Programs to be changed		3 Mo.	1/66	4/66	
6. Set Program Completion Schedule		4 Mo.	3/66	7/66	
7. Create operating system tape		1-1/2 Mo.	6/66	8/66	
8. Create Program Compatibility control decks		4 Mo.	9/66	12/66	
9. Redesign Input Requirements		2 Mo.	4/66	6/66	
10. Computer Room (New One Added)					
Layout		4 Mo.	12/66	4/66	
Construction		4 Mo.	7/66	11/66	
11. Operator Training		7 Mo.	6/66	12/66	
12. New Systems Indoctrination		2 Mo.	1/67	3/67	
13. Implementation (Parallel)		1 Mo.	2/67	3/67	

*Program Completion Schedule

Title, Specific Program Activity		Person Responsible
	Scheduled:	
	Actual:	

of the conversion. While certain problems arose during the process, the over-all conversion was completed on time. A major unexpected difficulty arose in working with the Compatibility Operating System modification: it would not be tested at the data center. Because the company's 1401 employed unsupported features and the manufacturer did not consider them standard, testing had to be deferred until the company's 360 arrived. The exact combination of 1401 and 360, Mod 30 features involved could not be tested through the use of a non-identical 30. The schedule provided four months of in-house use before total changeover to 360 operations so the in-house training did not delay the over-all plan. The inadequacy of in-house program documentation also came to light during the conversion process. Steps have been taken since conversion to insure that documentation for new 360 programs is more adequate. The detailed program completion schedule proved to be the bright spot. The work specified on it was completed six weeks ahead of the anticipated date. According to the programming manager the completion positively reflects the combined use of the schedule and the weekly status updating sessions employed.

Various other features contributed to the specific conversion process the company underwent. The data processing manager had been through many previous conversions. The records he kept of past mistakes, schedules, etc., provided a sound basis for planning the 360 conversion. A user seminar set up through the Data Processing Management Association was likewise felt to be extremely beneficial. A number of firms in the process of converting or planning to convert met weekly for about three months in mid-1966. Topics were selected from those which most concerned the users and prospective users at the time. IBM sent knowledgeable representatives to the meetings. The general interchange of information

among all involved was thought significant by the data processing manager of Wholesale Company 2. (Note: No official records were kept on this series of seminars.)

Case 8

Management intervention shaped the ultimate conversion experienced by Wholesaler 3. The reason for strong action from outside the data processing department will become apparent as the conversion situation is thoroughly presented.

A 360, Model 30 was ordered in late summer, 1966, to replace a 1401 disk system. The 1401 was operating nearly at capacity while needs for statistical data were increasing steadily. Disk and core storage space were limited on the 1401. The compatibility operating system had been ordered with the equipment, allowing operation of the 1401 programs on the new equipment with minimal effort. The new machine was delivered as scheduled fourteen months following the order.

A year followed the order before conversion efforts began. Knowing the compatibility features would be available plus heavy demands on the day-to-day work load of the small programming-systems staff meant that conversion efforts were part-time dealings on a catch-as-catch-can basis. Vague, written schedules were developed and changed constantly throughout the conversion process. The intention was to work with the machine and test various features for the first two months it was in-house. This meant 1401 operations would not be shifted to the new equipment immediately. The idea was to spend six months in part-time programming effort to rework the 1401 programs into native mode 360 programs. No concentrated work was done toward this goal until a month after installation of the machine.

The schedule did lay out specific details for preparation of the computer room. Three weeks prior to delivery, the 1401 was moved into spare space elsewhere. A raised floor was built and the old room received a facelift. Electrical wiring modifications were completed for the new equipment. At the time of installation there were only minor electrical adjustments to be made. It wasn't long, however, before there was some space expansion, which proved inadequate. Shortly after installation, peripheral units were added which had not been thought of earlier.

As the programmers became more involved with individual program translation or rewrite efforts, the depth of the conversion project's software phase became more real. The estimated six months for completion was realistically more like three or four years. The data processing manager (also a programmer) began looking into the possibilities of locating a consultant to help with the process. The 1401 programs were effortlessly shifted to 360 COS two months after installation while work continued toward getting them into 360 languages. The estimated total software conversion time had been based on the old 1401 environment. The technical information needed in relation to the concept and use of operating systems was grossly underestimated. Much time was lost to trial and error experimentation. While the staff had attended applicable language and operating systems schools two months prior to installation, the data processing manager emphasized that none of them learned much about the ramifications involved.

Three months after installation management issued a decree to eliminate COS and implement a major DOS application within three and one

half months. Management had become convinced native mode was the only way to go during the helter-skelter activities of the conversion procedure. They also did not foresee reasonable progress with the highly statistical systems they desired in the near future. The consultant investigated earlier was hired to assist with the project. Suggestions and ideas presented by the consultant lead to a revamping of the software conversion approach. Now a complete redesign would be enacted and processing methods were to be changed. Data file descriptions and their use were to undergo totally new thinking. All involved knew it was a pressure project. As is typical of 1401 systems, little help was available from documentation, for none existed. The lack of documentation at a crucial time lead to stringent requirements for completed and approved documentation before 360 systems could be implemented.

Inventory control was the main system of concern in the revised approach to software conversion. During the three and one-half month period, approximately 50,000 source statements were prepared and in use for that one system. The forced speed of the design-program-test-use steps directly attribute to the fact that the system "limped" during the first two months it was in operation. Highly inadequate testing meant many "kludge" routines were used to fix various mistakes in processing and in data storage. Management fortunately developed an appreciation for the effort and magnitude of the project, as well as the impact of its imposed decision, during the initial implementation of the system. It gave complete support to the effort during the critical early months of operation.

The sound support of high level management during early use helped a great deal in overcoming resistance to change and oversights in training. Users were consulted during all phases of the redesign, especially during

definition and testing. It was found that some detail and much "nitty-gritty" type information were not uncovered for the systems' definitions. Early implementation stages also showed that, even with written statements of purpose and use for all I/O forms there was a general lack of education as to how to use the output.

Experiences with the first systems lead to a slower and more thorough pace for the remainder of the conversion. More thorough program and system testing were provided including processing of considerable volumes of live data. Consideration was also given to the many new systems which were being considered for development and implementation. The net result after three years is that COS is still relied on to some degree for old programs although new systems and many converted ones do run in native mode.

The conversion process followed has lead the data processing manager to some convictions concerning prior planning. Next time he will know exactly what will be done before it's done especially regarding hardware features, user data, and operating systems.

Case 9

Machine ownership is an important factor in dealing with the conversion procedure followed by Wholesaler-Retailer 4. Both of the company's 1401 machines were purchased, as was its 360. The 1401's had been written off by the time the 360 was ordered, and a major portion of the work done originally on them is now processed on the 360 equipment. The 1401's, however, have been retained, contrary to original plans. Direct 1401 program conversion efforts were reduced giving priority to new applications. The 1401's currently function as

peripheral support units performing balancing and control.

The fact that the firm kept its old equipment did not mean its conversion was any less significant. The 360 was ordered with the idea of converting many complex 1401 systems to it and to accommodate growing needs notably caused by great company expansion. A Model 40 was ordered a year in advance of expected delivery in early 1968, and conversion preparations began at that time. Some findings during the year of research which preceeded the decision to order did help to plan the actual conversion.

Early projections were geared to make sure enough people were available and that priority systems were ready at the time of delivery. One programmer-analyst was added shortly after the order; another programmer-analyst and a trainee were added five months before the arrival date. Separation of data processing functions and a structured organizational set up came about well after installation of the new equipment. The department's growth and change are more directly attributable to company growth than to increased computer use and sophistication.

Programmer training in RPG and DOS began five months before delivery. With hindsight, it was felt more could have been done in-house to supplement the formal courses. Work was initiated on two critical systems as soon as programmers completed the courses. Redesign played a part in the process, but the redesign effects were limited to the EDP department. No changes were made to the first systems converted which would affect the user's procedures and understanding. Debug and test time were available at the data center. The testing phase led to almost total revision of the conversion plans intended. The programming language

used was inadequate for the task. A complete change was necessary.

A rush approach was adopted immediately to compensate for the language difficulties. Only three and one-half months were left preceeding installation. Scrap and restart was the only approach left. New language training was hurried, and all advantages of employees hired with prior experience in the original language were practically voided. A second redesign approach was adopted. At this point it was realized the projects were too complex for completion to coincide with the delivery of the equipment. It was decided to take delivery anyway and use the early months of machine time for testing and 1401 overload, via the compatibility feature. In actuality, it was nine months before the initial systems attempted were operational on the 360.

The software conversion was set back because of an inadequate language decision. The plan concentrated on the conversion of two systems particularly important to the company management. New uses and applications were anticipated, as was the conversion of all of the remaining 1401 programs. None of these intentions was formally presented in any sequence. Emphasis was shifted to new systems well before completing the conversion of any significant number of 1401 systems.

The hardware conversion schedule was not revised after the order was placed. The delivery dates dictated other action. One Mod 40 was anticipated a year after the order. The 1401 facilities were adapted for it by increasing the sapce and adding a raised floor. The actual work began two months before delivery, once the 1401's were moved to an alternate location. Optical scan equipment and remote terminals were to be delivered a year after the Mod 40, and a second Mod 40 a year after that. The equipment order further indicated a considerable number

of new applications would be developed in a fairly short time span. At the same time no date was set for selling the 1401's. The second Mod 40 was intended to take the overload from the first. The interim between delivery dates provided valuable experience with multiprogramming and multiprocessing, the advent of an improved computer, a change to faster, nine-track drives (i.e., those designed for 360 use), and saw retention of the 1401's. These combined factors vastly increased efficiency and resulted in less than two hours a day process time on the second 40. The processing unit, tape, and disk drives of the second 40 were returned to the manufacturer seven months after they had arrived.

Reliance on 1401 methods and thinking shaped initial use of the 360 in numerous areas including standards, operation and documentation. Labeling tapes were done in accordance with a special 1401 method. Programs were processed on either or both machines, so labeling consistency and like tape drives were required. The method was not efficient for the 360, and was extremely difficult to accomplish. It was also undesirable as the 360 system provided an easy method of developing standard tape labels. Yet Wholesaler-Retailer 4 initially had second generation based tape drives and relied heavily on its 1401's, so the 1401 method of labeling was maintained. Logic flows, file design, and layouts were similarly based on features on the 1401 and the practice of allowing programmers to run the machines during check-out led to abuse of typewriter messages. It took some time to eliminate heavy use of the console typewriter from early 360 programs. The computer system's own console messages have been more than enough for the computer operators to cope with. Their training was limited to on-the-job learning from programmers. The operators have not been prepared for subsequent changes to the system.

The program and system documentation standards were uniquely complete. The folder on each system included narratives, operation procedures, current, dated listings, all layouts, etc. The completeness was most advantageous during conversion efforts for the 1401 systems. Only minor changes have been made to the documentation requirements to adapt to specific 360 features.

Adequate plans, short and long range, were not present to guide conversion efforts, especially in the software area. Time and pressure were not critical elements. There was little concern that nine months passed before anything was operational on the 360. The result was a flexible, creative, but lax, atmosphere. Learning and adaptations which changed the picture, seen at the time of the original order, were not used to update the hardware configuration intentions specified. A number of old programs are still processed on the 1401's and through the compatibility feature of the 360. At the same time many highly-sophisticated applications have been developed and successfully implemented to meet the requirements of a rapidly expanding business.

Case 10

High level coordination, planning, and development guided the conversion experienced by Wholesale-Retailer 5. A parent organization made all the decisions and did all the development work to insure nationwide standardization of operation. Long-range schedules were published by the parent company so individual installations could make adequate preparations. The prime responsibility of the local operation was to insure accurate, timely processing and to maintain parent developed systems. The local EDP department was allowed to develop applications for

unique circumstances and to adapt various elements better to match its situation.

The company had run the gamut of the 1400 series of equipment before converting to System 360. Growth, experience, and increasing applications lead them through various 1401 systems and on to the 1460. Individual operations were to begin 360 operations with a Model 40, ordered locally. The specific order was placed about a year in advance of the scheduled use, with the understanding it was easier to delay than to hurry an order. The actual delivery date was dependent upon parent company application development.

Site preparation was left up to the local EDP department. Development work was done under the direction of the Installation Engineer, assuring standards for the configuration to be installed were met. In this particular case, a new location was prepared for the entire EDP operation. Timing was a critical problem. The distance involved meant it was necessary to remain at the old location and maintain production there until the exact installation date and change over. At change over, the 1460 operations were run under emulation and compatibility, which was the first step in the master plan for software conversion.

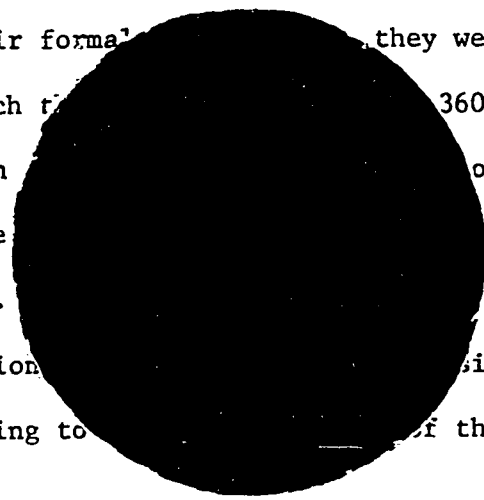
Retraining for EDP personnel began six months prior to installation to allow phasing. Programmers attended manufacturer schools two at a time. Their training continued through the direction of the parent organization. The parent organization also developed an on-site training program for the computer operators. Most of the operator education occurred during testing procedures right after installation. Various standards were published by the parent EDP department to help the training process. Especially helpful to the programmers were the published

tips on logic and "do's and dont's."

Specific applications' conversions were coordinated by the parent organization, department for department. Specifically those aspects directly affecting the data processing department were under the parent EDP staff, accounting aspects under the parent accounting staff, etc. The high degree of coordination necessary meant that completion times were forced. Programs were developed and tested at the head office. Information was passed on to those involved during development and testing to help them prepare for ultimate use. Once an application package was completed, it was implemented at the various local installations by a parent implementation team working on site with the local EDP staff. This meant the individual installations did not convert applications simultaneously, but rather as the implementation group got to them on the schedule. The set up allowed adequate time for modifications to the packages to meet local peculiarities such as sales tax, payroll, or legal requirements. Parallel test runs were done on site until the user department was satisfied with the results obtained from the new system.

In the case of Wholesale-Retailer 5, a local team was set up in advance to assist with the conversion. Teams were formed on a user department basis, one per department. A user, a coordinator, and a data processing person were on each team. The coordinator is of particular interest in that he was chosen because of his knowledge of operations from the user's standpoint. The group worked together to insure a successful conversion from the time that parent intentions for the specific application were made known. The team of workers was dissolved as soon as the package was successfully implemented. The concept added local coordination and was added to the scheme of parent-department coordination.

Local applications are small and much less significant than those handled through the parent organization. Emphasis was placed on day-to-day operations of the parent systems, so conversion of the local programs was done as time permitted. Redesign efforts included user guidelines. Once it was explained to the user that it was convenient to change at a certain time, his cooperation was assured. The result was that few programs required much more than a re-code approach. The users, for the most part, were already getting what they needed. As programmers had time, after their forma[redacted] they were able to code the local applications which t[redacted] 360 operations. No dates for the completion [redacted] owever, the completion will nearly coincide[redacted] version handled through the parent company. [redacted] lapsed since the local original installation[redacted] ions occuring throughout that time according to [redacted] f the parent data processing department.



The local firm felt the following factors were critical to their conversion efforts:

(1) Published long-range schedules
(2) Department by department coordination
(3) Local equipment order
(4) Data processing training program
(5) User training program
(6) Application by application implementation
(7) Test phases
(8) Local implementation teams

The parent organization acted as a software house throughout the conversion. In the central position, the home-office data processing was in a unique position. Top-notch personnel were obtained and maintained. Extensive records and previous documentation were available as a guide.

Manufacturing Cases

Like the Marketing Area cases, the Manufacturing concerns investigated were concerned with inventory control applications among their many data processing uses. A particularly interesting aspect of manufacturing data processing operations is the number of "on-demand" jobs involved. Various scheduling and bidding problems require a number of jobs to be run as they are needed. A given demand job may be particularly complex and require a great deal of computer time, while another may be straight forward and require very little run time. In these cases scheduling computer operations becomes fairly complex. While this particular problem did not directly relate to the conversion activities undertaken, it was of constant concern to several of the manufacturers.

Case 11

Manufacturer 1 concentrated its work in three areas during the seven months it had between order and delivery of a 360 Model 30: file and software conversion; schooling; and site preparation. The 360 was ordered as a more efficient means and to replace two 1440 disk systems. The new equipment configuration included disks, tapes, and emulation hardware. Delivery was set for the last quarter of 1968. The point in time is important, because by that time there was a significant amount of information on 360 peculiarities made available. Order waiting periods were considerably less than was the case with equipment ordered in 1964 and 1965.

Site preparation was the least complex of pre-installation work done. New programming offices were constructed near the existing machine room. The computer room itself was completely rennovated for the 360

Local applications are small and much less significant than those handled through the parent organization. Emphasis was placed on day-to-day operations of the parent systems, so conversion of the local programs was done as time permitted. Redesign efforts included user guidelines. Once it was explained to the user that it was convenient to change at a certain time, his cooperation was assured. The result was that few programs required much more than a re-code approach. The users, for the most part, were already getting what they needed. As programmers had time, after their formal 360 training, they were able to code the local applications which they already handled for 360 operations. No dates for the completion of these was established. However, the completion will nearly coincide with the last application conversion handled through the parent company. Two and one-half years have lapsed since the local original installation, with applications conversions occuring throughout that time according to the published plan of the parent data processing department.

The local firm felt the following factors were critical to their conversion efforts:

(1) Published long-range schedules
(2) Department by department coordination
(3) Local equipment order
(4) Data processing training program
(5) User training program
(6) Application by application implementation
(7) Test phases
(8) Local implementation teams

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configuration. The entire site preparation project was completed during the two months just prior to installation.

The other two areas of prime concentration required more direct time and coordination on the part of the data processing manager. Before the order was placed the data processing manager relied on books and contacts with other users for a basic understanding of the contemplated computer system. With that basic knowledge and by taking the complete series of 360 Programmed Instruction courses after the order the D.P. manager determined the basis for training the rest of the staff.

To insure that the operators were familiar with the operating system messages and required responses, they were sent to school. Except for the operating system introduction, programmer training was an in-house project under the direct supervision of the data processing manager. Because the data processing manager felt that programming is primarily a logic feature which his staff already possessed, attention was directed toward a new programming language. The staff of five worked as a group in a forty hour introductory series. The group met evenings and Saturdays allowing day-to-day work loads to take precedence during normal work hours. It is significant to note that programmers were promoted from the operations staff of Manufacturer 1. Once the training session was completed, the programmers were assigned research topics to provide more depth to the group's understanding in specific areas. Some of the areas were job control of language, conversion of data files, cataloging, etc. The projects were in addition to normal tasks. The information was presented and used during scheduling and development sessions for software and file conversion.

The immediate plan following installation was for emulation of the 1400 systems on the 360. The development of all new systems was delayed until the new equipment was installed and satisfactorily running the old systems. The short-range goal was to resystematize the old programs for native mode 360 operation. A one-year projection was developed in bare outline form, with work to begin about a month prior to installation. The programming staff was split into new development and maintenance groups. While those in new development were to work full time at 360 projects, those in maintenance were to work on conversion projects as time permitted. One of the full time 360 project programmers was assigned the task of learning to generate the operating systems (COS and DOS) to be used, i.e. initiating the operating features on the machine. No data center time or other outside computer time was used prior to installation and manufacturer support was not called upon at any time. For the resystematization phase, attention was given to what the systems should do, how to use the 360, and how the input and output should look--all from the standpoint of the data processing department.

File conversion was viewed as an extremely critical element of the software conversion. Many chart forms were used in brainstorming sessions to detail everything thought to be involved. Studies were made concerning the specific placement of every data file used in the total portfolio of programs. Specific attention was given to disk file arm positions to provide the best speed and efficiency of retrieval. Particularly in the case of data organization and file structure, the entire project was broken into many tasks thus allowing staff members to work on small jobs.

Installation and implementation of the 1440 programs under the compatibility feature went smoothly. The 1440s were released after only one week. This week was filled with overtime. Operating system generation, testing, and file conversion efforts were initiated and completed during the week.

A number of problems arose as the 360 redesigned versions of 1440 systems began to be implemented. The EDP department had made arbitrary decisions as to what was needed for redesigning. Once input and output formats were determined, responsibility for them was left up to the user departments. Project completion dates were presented to the users. No formal user manuals were prepared or presented. The result was that data processing was ready and the departments were not. Faulty input was common for some time following the implementation of each redesigned system. The problems were traced to inadequate user system education throughout the entire process. Users were not included intimately in definition phases, and sufficient flexibility had not been built into the converted systems. All input-output responsibility was up to the users, but their education was lacking. After two years of 360 experience and computer application growth, about a quarter of the original 1440 programs remain in operation under COS. It had been projected that resystematization of the 1440 programs would take only a year.

An increasing business and the sophistication of the 360 lead to an EDP departmental reorganization. All functions were responsible to the data processing manager during operation of the 1440's. Three groups were set up with separate managers: key punch, operations, and programming-analysis.

A singular feature of the conversion process of Manufacturer 1 was that it was entirely an in-house operation. Even manufacturer help was essentially avoided. The conversion procedures operated almost completely within and for the EDP department. The complete separation of EDP from user did not provide entirely satisfactory results. To obtain an adequate working knowledge, many extra hours of work were required by staff members. Much of the conversion preparation was done as an extra-curricular activity to the normal work load.

Case 12

Growth of the data processing department and expansion into computer systems areas lead to the conversion experienced by Manufacturer 2. Growth also lead to the addition of special features within the data processing department, facilitating the conversion and new applications. Historical charts had been kept showing the increase of processing hours used and the increasing number of systems in operation. The charts provided insight and indicated the approaching inadequacy of both storage space and computer time. A control system, shown more completely later, was added to the EDP operation to assist with conversion efforts and all future computer use.

The series of equipment used preceeding installation of third generation machinery provides an essential understanding to the total conversion picture. This is true because in some ways, Manufacturer 2 "got his feet wet" in third generation thinking through the use of 1460 equipment. The 1460 system was ordered after the 360 was announced. Often considered an intermediary step, the 1460 provided working opportunity for developing more "third generation" oriented in-house software. The

ultimate intention, even at that point, was to grow into 360 operations. Teleprocessing applications were implemented on the 1460 and quickly became a growing feature. Shortly after installation of the 1460, 360 equipment was ordered for delivery. The intention was to emulate the 1400 series programs on the 360. As the teleprocessing success with the 1460 became apparent, a Model 40 was also ordered for the express purpose of expanding teleprocessing (T.P.) operations. Manufacturer 2's use of T.P. on the 1460 is significant because many feel that T.P. is a third generation software concept.

Physical preparations, the control system, training, and testing were considered in detail during conversion preparation planning. All efforts were coordinated to coincide with the delivery date.

Space was at a premium at the time the Model 30 was due to arrive. The Facilities Guide, a manufacturer developed manual, served as a continuous reference during the weeks of relocation decisions. Many layout charts were developed before finally working up a satisfactory room pattern. Once the layout of equipment was established, plans were made in conjunction with the firm's building and maintenance staff for electrical wiring, air conditioning, raised flooring, and forms and tape storage space adaptations. Preparations for site adaptation were more complex when the Mod 40 was installed. A new location for computer space had been located. The teleprocessing aspect of the changeover needed highly coordinated efforts between physical facilities, the actual equipment, and the many telephone lines used for I/O. Each T.P. user was notified in detail of the planned events two months in advance.

The utilization charts which were maintained for 1400 operations

provided forewarning of the degree of expansion coming in the firm's use of EDP. Records showed the department was fast outgrowing the rule-of-thumb stage in the area of control. A sketchy set of procedures was planned for the original control staff. The procedures covered such elements as programming standards, systems standards, user limits, and logging requirements. Also included were procedures for key punch, the control group itself, and computer operations.

A control group was established. Its initial responsibility was to initiate control procedures relative to conversion. Later its responsibilities were to insure control of data, and to build, and maintain the original set of control procedures. (User processing time limits were a particular problem in relation to manufacturing and inventory control. The nature of the systems requires them to be run on an on-call basis for either very small or extremely complete listings. Operators never knew how long a particular requested job would run. The control procedures helped establish control over the frequency of requests. Processing time estimates from the users were required to allow reasonable job scheduling throughout the day or week.)

Before delivery of the Model 30, training was devoted to emulation-related topics. Nine months before delivery the programmers were phased into a series of courses, concentrating on the operating systems to be employed. The phase was completed in three months. Operator training was an in-house project. The programming manager and the operations manager combined talents in presenting classes geared to provide a familiarization with necessary control cards. Modified run books were developed and presented prior to installation. Of particular help was the complete

drawer of pre-punched control cards which could easily be selected by an operator to meet a specific job. This eliminated the need for operators to develop control cards on the spot, and subsequent errors.

A series of charts was developed detailing each conversion phase for every application package in use. The first phase involved programming changes for emulation. Modifications were also made to the COS package for peculiar features which had been used on the 1460. The programmers were assigned to check-out activities before delivery and for the month following installation of the new equipment. Most of the month of in-house testing was devoted to parallel operations with the 1460. The second month was allowed for phasing the actual changeover.

Although it was realized some day a change to native mode operations on the 360 would be needed, no positive plans were made in that direction. The old systems were maintained as 1460 programs. New systems, however, were developed on and expressly for the 360. Nearly two years after installation of the first 360, all of the 1460 programs were still being run under COS. Top level management stepped in and stopped emulation. The action resulted in scheduling for redesign and recoding work to fit along with the developmental systems. Work is still in process toward completion of this "forced" phase of conversion.

Case 13

Manufacturer 3 went through a conversion to third generation primarily to bring the computer operations back in-house. At the time the change was made from unit records to 1401 processing, the firm chose to use a service bureau for its programming and processing needs. After two years the management found that volume increases were becoming prohibitive

on the very basic accounting systems in operation. There was no chance of adding the many new systems they desired without an in-house computer and data processing staff.

A data processing manager was hired and a 360 Mod 30 was ordered simultaneously, about eight months before delivery. Under rather unusual and congenial relations, the data processing manager was able to take over responsibility for all of the programs developed and run by the service company. Arrangements were worked out to continue processing efforts with the service company until the Mod 30 with 1401 compatibility features was delivered. The service company itself installed a 360 with COS six months before Manufacturer 3's was due. Everything was set up for COS by the service company. Manufacturer 3's data processing staff eased into the operation of production runs on the Service Bureau's computer during the last three months. Because of the exceptional set of circumstances, all of Manufacturer 3's systems had been running successfully under the exact 360 set up they installed in-house. For six months before installation they had access to another machine.

The June, 1967, delivery date was not as critical to Manufacturer 3 as such a date was to most installations. There were, however, many important data processing tasks to be performed which other conversions did not require. First of all, there was no data processing staff, except the key punch section. A programmer was hired seven months prior to installation. The data processing manager and the programmer formed the systems analysis-programming staff. The two immediately attended classes for an entire month. An experienced computer operator was hired to manage the operations staff, which was increased to three prior to installation.

All operator training was in-house and on-the-job, based on the data processing manager's experience. Both hiring and training were affected by strong company policies of promoting from within.

Bringing the computer operations back in-house meant that complete computer facilities had to be prepared. The first problem was to locate adequate space for the staff's equipment. Planning for the office and computer room facilities needed began in January. Key punch, programming, and operations offices were established first and located close to the anticipated computer site. Steps were then taken to free the required floor space for the computer. Some resistance was met as people had to be relocated within the company to allow for the computer. Construction work was started for the computer site three months before delivery and included raised flooring, special wiring and air conditioning, and show-case type glass room partitions. The facility was completed three weeks in advance of the delivery date.

As mentioned before, a considerable backlog of systems desired by management had accumulated during the time the computer operations were carried on through the service bureau. The backlog meant emphasis was placed on compatibility mode operation of existing systems and the development of new applications. While emphasis was on the new, there were no urgent schedules. The relaxed atmosphere and the knowledge that the 1401 programs had already successfully run under COS provided an opportunity to take an experimental approach in developing the new applications. Actual design and programming work for the new, native mode systems was started as soon as the programming and operating systems schools were completed. The 1401 programs were to be converted to

native mode as time and need permitted between new applications. Only one major 1401 system had not been converted to a 360 language program three years after installation of the Mod 30; there has been no need to convert this particular system. The basic approach taken with those systems converted was to eliminate as many manual operations as possible. The first step was to eliminate all card-based data files in favor of the significantly faster I/O and processing times possible through the use of tape.

Administrative "tip" sheets were prepared by the programmer-analyst responsible for a system. The tip sheets were types of instructions, for the users of new or redesigned applications. They were the prime vehicle providing user education. A new position evolved from the good and bad features of the tip sheet procedure. An office systems and procedures analyst acted as a liason between user and data processing. It was his duty to arrange meetings, education sessions, etc. The uniqueness of the position is emphasized by the fact that he was not essentially a data processing person, but rather more familiar with the firm's entire office operations.

The initial EDP staff was small, and word-of-mouth standards and procedures were adequate. General rules were written as the staff grew. A specific set of documentation requirements was prepared.

Manufacturer 3 enjoyed unique advantages during the conversion process. The service bureau was especially cooperative in returning control of the programs to the firm and in helping the new EDP staff learn to maintain and operate them. The service bureau itself converted to the same 360 system Manufacturer 3 had ordered. The bureau

carried out all the work in preparing for, testing, and operating the programs as they would be run on Manufacturer 3's equipment. Once the equipment was installed and tested, the old programs, tapes, etc., were merely moved back in-house. The unusual situation took off much pressure which normally accompanied conversions.

Case 14

Less than three months separated the order and installation dates for Manufacturer 4's 360 Mod 30. Between data processing and company management the actual decision to order had been an on and off affair for some time. The firm was using a 1401 disk system to capacity at the time. Virtually no efforts were directed to preparations for the new equipment until the order had been placed. Decision and action were condensed into a brief time span.

Two target dates were established to direct the conversion procedure. The delivery date became the target date limit for preparation of the physical site for the computer and for training those who would directly use the equipment. Adequate space was located in another building so rennovation work could be carried on without interrupting daily operations. The construction and adaptation was completed in time for delivery. Only little things were found inadequate, such as misplaced cable, during actual installation work. Programmers attended two class sessions devoted to explaining basics about the 360 and the Compatibility Operating System. Classes for the operators were held in-house a week before the machine arrived. The goal of the training for the department was to make COS work. All 1401 jobs were to be run under COS and maintained in 1401 language form.

The second important target data was dependent upon making COS work for the firm's data processing operations. Parallel operations were scheduled for the first month following installation. The 1401 was to be released and moved out at the end of that month. Work on data files and the firm's entire set of programs were related to meeting the 360 implementation date. Data file conversion required manufacturer assistance as there was no in-house means of getting 1401 disk data onto 360 disks. File definitions and formats were developed for each set of data used. A catalogue of all 1401 programs was developed hand-in-hand with the file definition project. The list served to check that all programs were properly prepared for use under COS, and later that they had, in fact, been checked-out during the parallel test period. A brief arrow diagram was drawn up to insure these supporting events would coincide with the delivery date of the 360 and the release date of the 1401. The target date expectations were met.

After changing to operation of the 360 under COS there was no intent to change the 1401 systems to 360 mode programs. Data was limited to card format and card reader speed. Maintenance work on the programs was to be continued. Program patches in 1401 languages were favored over rewrite or redesign efforts. There was no attempt at developing a new approach to design or operation of the systems in the firm's portfolio.

Two and one-half years after installation of the 360, strong action was taken by top management. A new data processing manager was located and hired to streamline and improve the efficiency of the systems in existence and to set up a development program for many new applications.

The viewpoint which management and the new data processing manager shared showed that the evaluation, determination of requirements, and work which needed to be done three years after installation was no different than it was before the 360 order was placed. If anything, the problems generally associated with 1401 operations such as lost, inadequate, and nonexistent documentation, had been increased by the great number of program patches made since initiating COS runs. Priorities were assigned to the old programs and the applications that management wanted developed. New members were added to the programmer-analyst staff and detailed design work was begun.

The second conversion to third generation is still in the design and preparation phase. The intent is to develop specific tasks, standards and as much documentation as possible before any programming, debugging, testing, and implementation begins.

An education program is in process to change the thinking of people inside and outside the EDP department. Users, operators and programmer-analysts are still, after three years of 360 use, basically card-oriented.

For Manufacturer 4, much of the work for the 360 conversion process is being repeated well after that process began. It is being repeated to get the results expected previously. Some of the conversion work is being done for the first time. The reconversion appears to be more encompassing and systematic than the first. The reconversion also enjoys an environment based on considerable 360 use, knowledge and understanding.

Insurance Cases

The use of applications packages was particularly noticeable among the insurance companies investigated for this study. Many life insurance firms had installed a major applications package, 62CFO, on their second generation computers. While the package was designed for general use, it required extensive work by the firms. Programming adaptations were required to take care of company idiosyncrasies. Extensive training and even some companywide reorganization was required to handle this comprehensive system. The 62CFO firms were none too eager to change the numerous and highly interrelated programs of the system to native mode bases, and they regarded emulation as essential. A special users group was established for insurance firms with the 62CFO package across the country.

Third generation packages are now being prepared. One of the firms investigated converted primarily to be able to install one of these new major packages, ALIS. Similar to 62CFO, ALIS is also a package designed for life insurance companies.

Case 15

Growth played the leading role in Insurance Company 1's data processing history. The volume of data to be processed increased even more rapidly than did the number of systems to process them. Data processing operations began in 1963 with a 1401 tape system. The equipment was obtained primarily in anticipation of a manufacturer-sponsored insurance package, 62CFO. A number of in-house applications were implemented while waiting for the completed version of 62CFO. Once the

ordinary life insurance system was available, there was a considerable amount of adaptation work necessary before it met the firm's own requirements exactly. Work had also begun on other major in-house applications. In the meantime, the processing volume of earlier, less comprehensive applications had increased to the point at which a larger and faster machine was needed. A 1460, the largest of the 1400 series computers, was ordered for delivery in December, 1964. The 1401 systems, even those not yet completed, would require little if any modification to run on the 1460. Six months before the 1460 delivery date a 360 was ordered to replace it in late 1966. The 360 was ordered within days of its formal announcement.

The concern of Insurance Company 1 was not the 360, but rather the 62CFO system and the more complex in-house systems. It had taken eight months of debugging and testing on the 1460 before the applications were operational. Compatibility was the route chosen for all systems developed and implemented before installation of the 360. New systems were, however, to be developed with the use of third generation languages. Redesigning or rewriting the old applications was out of the picture; therefore, no detailed plan for software aspects of the conversion process were developed for the 360. Training preparation received some pre-installation attention. Programmers were phased into all schools available as they were freed from implementing 62CFO and the other major applications. The operators received only limited training through Systems Engineers immediately following installation. Construction work was started to enlarge the computer room's floor space ten weeks ahead of delivery. The other adaptations normally required

such as additional wiring, raised flooring, and increased air conditioning were already sufficient to meet the requirements of the 360.

Most of the pre-installation effort was directed toward testing various features of the Compatibility Operating System. Both data center and purchased test time were used. The time was devoted to some parallel type preliminary check-out activities and to file conversions as possible. A month of parallel run time was allocated in-house for final assurance that all input would be accepted and to verify that the output was the same. Those files not converted beforehand were compensated for as the configuration installed had two seven-track tape drives which is the variety compatible with the 1400 equipment. The comprehensive test features further included creation of the necessary control cards for each job.

Once the formal classes had been completed, the programming staff made a series of recommendations concerning compatibility and native mode operations. They presented a set of guidelines for a complete software conversion; however, the recommendations were not accepted. The underlying view was that the use of three partitions, as planned, made "running a Model T on a Cadillac" feasible. Since installation some of the old programs have been redone using 360 languages. Volume runs and certain programs not highly interrelated with a complex system were changed as time permitted.

Case 16

Similar to many other insurance companies, the complexity and time invested in 62CFO greatly influenced Insurance Company 2's later data processing decisions. Two years of modification work with the

package were required before implementation on the firm's 1410. The entire company was oriented to the concepts of the system and its daily run features.

As encompassing as 62CFO is, the company had many lesser applications in operation on the 1410 and a 1401. Processing time became scarce as processing volume and the number of systems increased. Development time was practically non-existent. A 360, Model 40 was ordered to provide increased speed and volume capabilities, as well as for the new features such as the compatibility feature and the support it offered. Also, two processing hours per day were always to be available for new applications and development work. The intention at order time was to rely heavily on the Compatibility Operating System so minimal efforts would be needed for software conversion. There was not much done in the way of preparation during the year before the equipment arrived. While the 1410 was to be released, the 1401 was being retained. The 360 would take over the 1401 work and any 1410 overload. It would also provide considerable "expansion" time, with two hours a day scheduled for program development throughout the 360's days at the firm.

Additional space was needed to house the new computer. The space was the only important factor, because adequate wiring, air, etc., were already available. The building had been constructed with moveable panel-type walls, so physical expansion was fairly effortless.

There was no real effort to get anything new on the 360 when it was brought in. Providing adequate processing time was an important aspect. Once programmers completed language and operating system training through manufacturer classes, required rewrite efforts and new systems

were prepared for native mode 360 operation. There was no set number of systems or area of software work to be completed before installation, or at any particular time following it. Some work was, however, completed and tested at the data center before the in-house equipment arrived. Except for the implementation of very major systems such as 62CFO or major changes to it, systems development and changes have been done as the need evolved; no different approach was taken for conversion. Formal training for the EDP staff was limited to the basics. Consistent help from the Systems Engineers was the primary source for the programmer's and operator's real learning. Offices were allocated to the S.E.'s who were present for a good two years, until the insurance company's own staff had its feet well on the ground. Redocumentation was included during the process of changing over the old system.

The data processing manager was careful to point out that conversion cannot be over at the time of installation. The continuous flow of operating system release versions and various other hardware and internal software developments provided a continuous flow of change.

After two years of 360 use, two significant changes in operation were initiated. First, it was decided that emulation was not the best method. More concentrated efforts were subsequently directed toward redesigning all the systems operating under COS for native mode operations. Simultaneously, fairly detailed plans were set down for changing 62CFO to include teleprocessing features. The interrelatedness of the 62CFO programs and the far-reaching effects of T.P. meant that well developed change plans, work, and testing were required. A company-wide orientation and training procedure accompanied the change, similar to the procedure used when the system was initiated. General seminars were held to discuss

the decision and its implications on the whole company's operations. Individual departments were instructed in detail on the phases which involved them, a procedure which became concentrated immediately before implementation. The I/O control group helped considerably in post-installation training for the various unanticipated factors which arise.

Emphasis was on manpower allocation and preparation. No real implementation plan or schedule accompanied the 360 conversion to guide the entire procedure. The situation is being revised for equipment on order for future delivery. A highly detailed plan is being developed with activity geared to coincide with the delivery schedule.

Case 17

Merger activities greatly altered the initial plans Insurance Company 3 had for its conversion to third generation computer equipment. The effect of the merger became apparent as the conversion preparations and procedures were effected.

Continuous spot checks on volume and processing time utilization on the 1401 were used to predict future requirements. By 1965 the need for increased space and time and realization that third generation was truly eminent lead to pre-order activities. The data processing manager and his right-hand man attended introductory 360 systems and basic language courses. They took the courses to gain sufficient understanding to aid in making a decision whether or not to place the appropriate order as well as to learn what action would be required to complete the desired change. An order was placed twenty months before delivery. At order time the decision was to follow primarily an emulation route. The

decision included knowledge of the fact that a good deal of work would be required to adapt the emulator package to special features which had been developed for the firm's 1401 applications. The main goal was to have the special features completely operational through COS by the time of installation.

A schedule was developed for activities leading up to the actual change of operations from the 1401 to the 360. Additional training was scheduled for the staff: manager, programmers and operators. Two months of in-house work with the compatibility package and the modifications to it were included. All of the data center test time was allocated to development and testing the emulation features and modifications. The elements leading to operation of the features were plotted in detail. Eight months were allowed in the schedule. Completion of the phase was essential to any use of the 360 equipment.

A second phase of the software conversion was directed toward completely changing all the programs to native mode 360 languages. Both phases required a complete enumeration of the program in use. A priority schedule showed those which should be prepared for native mode operation immediately and the order in which others should be completed. Work on the individual programs was to begin when the emulation package was completely ready for operation, supposedly some time before installation. Assurance that the package was matched to the firm's processing requirements was intended to take the pressure off individual program conversions. It was realized that all the redesign, coding, and testing work required to complete individual program conversions could not be done before the desired change over to 360 operations. A schedule, however, was developed based on priorities.

Plans also included the development of a data center area. The firm announced general building plans shortly after the order was placed. Because construction changes were planned on a company wide basis, the EDP department had a coincidental opportunity to design space for the whole department. A special systems design room, offices for staff expansion, and a new computer room were designed. Tape and forms storage facilities were included. Meeting company wide construction deadlines, the EDP facilities were to be completed a month before delivery, after five months of work.

The construction plans went as scheduled, but the software phases were disrupted considerably. Merger talks began while planning for the 360 was taking place. Some software work had started by time the merger was formally announced in July, 1967. Installation of the 360 was to be in October. Activity was necessarily directed toward making the two companies' data processing procedures compatible. Many one-run merger routines had to be developed. All merger activities had to be completed to meet first of the year legal stipulations.

Completion of the emulator modifications was even more critical at this point. All plans for program conversion to native mode operation were dropped. A procedure was developed to process file conversions close to the installation. Tape files from both companies' 1401 systems were converted for use on the 360 during the two month check-out period which had been provided. The merger routines, the merger conversion, and operation of the 360 under emulation were completed as scheduled. Once the loose ends were cleared up, the second phase of the original software conversion plan was resumed. The priorities which had been

assigned remained the same; only the time factor had to be altered.

Case 18

Massive change and expansion accompanied the conversion to third generation computer equipment experienced by Insurance Company 4. The staff grew, changed its approach to design and development, and altered its concept of systems and data. All of these changes were directly related to conversion from 1401 to 360 based operations. Not all of the changes, however, were anticipated.

Space and time were limiting factors to further development of 1401 applications. A Model 40 was ordered shortly after formal announcement of System/360 for delivery in 1966. The data processing manager and his three programmer-analysts worked together to formulate early plans and to make initial decisions. The first action was to choose the basic programming language and the main conversion method. COBOL was selected for new application programming. The compatibility feature was used to allow a mere transfer of 1401 operations to the 360 for the initial period. One of the programmer-analysts was allowed to spend most of his time before the delivery date in "blue sky" type thinking. His objective was to decide how best to use the machine, in a third generation sense, and in relation to the company's need for applications.

The number of new applications on the docket indicated a need for a considerably larger programming staff. A steady growth pattern was established in 1965, about a year before the expected delivery date, and continued until the staff reached twenty-five in 1968. Conditions at that time were such that experienced programmers were practically non-existent. A new approach to systems design, programming, and training was adopted

to meet the situation. No longer would the programmer-analyst concept be used. The original staff would become systems analysts with the task of developing very explicit definitions. The analysts were to create definitions which would allow the programmers to be no more than coders. The selection of COBOL as the prime coding language was also directed toward the quick training and fast production status needed. All the software intricacies were left up to the original staff. The approach was primarily put into operation to take care of small, quick jobs.

The manufacturer-sponsored schools were used as training bases. Their limitations were, however, recognized. The schools provided a good chance to become acquainted with the many manuals which accompanied the 360 and its various operating systems. The language schools were just that. There was no emphasis on "programming," especially directed to change programming concepts from a second to third generation orientation. The code-from-the-narrative procedure used was an attempt to bridge the gap for those programmers who had some prior experience and to ease the whole process for those with no experience.

Use of highly developed systems definitions and the coder concept also served to alleviate a problem which occurred with the 1401 program. No documentation had been prepared. The new approach was almost self documenting from the standpoint that much which was normally included in documentation packages was completed formally before the coding phase. In conjunction with the documentation standards, a number of technical standards were established for systems, programming, and operations. Consistency emerged among program names and numbers, the procedures, and various programming techniques. The increased formal standardization follows a general trend in this direction from the very informal

standards and techniques used in the days of unit records systems.

The initial conversion (i.e., emulation of the 1401 jobs under compatibility), was not particularly significant, nor was it expected to be so. The 1401 programs ran just as they had, each as an individual function. During the first year a number of relatively small, native mode systems were implemented. The release of COS brought a change in thinking concerning the 1401 programs. The new emulation system provided a new operating environment: the stacked job situation. While the concept was available for the 360 native mode programs, not everyone had adjusted to it. Use of COS forced the adaptation.

During the first year of operation, the results of the "blue sky" efforts of the single programmer-analyst began to take shape. A five year plan of systems development was drawn up. The first system in the plan was the core of the entire plan. An approach totally different from those taken with previous systems was enacted. The system employed the data bank concept, utilized remote terminals, took some forty-odd programs and required a year and a half for completion. The system and the five-year plan soundly noted the real impact of the change to third generation. Reliance on the data bank and the highly integrated approach of both the initial system and those based on it moved operations into a new environment. Jobs ran continuously as needed, and they all had access to the same information. It was with the implementation of the initial system specified in the five-year plan that Insurance Company 4 felt it had in fact converted to third generation.

Case 19

Space became the deciding factor in 1965 when Insurance Company 5

ordered a Model 30. The capabilities of the 1401 were occupied with systems designed primarily to provide top management with better operating information. Plans were under way to move into computer operations which would reduce clerical costs and increase customer service. A larger and faster computer was needed for the planned tasks and to keep ahead of increased volume throughput with the existing programs.

The importance placed on the new systems development led to two basic decisions made in conjunction with the equipment order. An emulator package would be leased with the equipment so none of the existing 1401 programs would have to be rewritten for the 360. All of the new systems designed and written during the eighteen-month waiting period would be done in COBOL, allowing active mode operation. This second decision also meant that no new systems would be implemented until the new machine was installed. Together with the delivery date, decisions to operate under compatibility and to do development work for 360 mode operations steered the preparation phases in advance of the equipment.

Immediate operating system and language training was required for the programmers. In order to begin work on the new systems on the docket, they had to have knowledge of the tools necessary for native mode operation. The programming staff was sent to formal schools on a rotation basis. One senior programmer received concentrated training in the operating systems which would be used on the equipment configuration ordered. Systems analysts received in-house training oriented toward systems considerations relative to the 360, not the technical detail required by the programmers. The training provided the base for systems and program development prior to the availability of data center test time and the installation.

Shortly before installation the computer room supervisor attended basic operations classes. He, in turn, was responsible for training the other operators during outside test time and during the initial month's use scheduled for parallel testing and new systems check-out. The need for operator understanding steadily increased as operating system features advanced and became increasingly sophisticated during the "life" of the 360. Changes such as going from a tape oriented system to a disk based one, and from separated I/O operations to the spooling technique will lead to confusion and error unless the operators are properly prepared for them.

Planning for the actual computer site was simultaneous with the training phases of the conversion preparations. Air conditioning, electrical, and flooring studies were arranged contacting outside contractors. The facilities were completely ready for the equipment two weeks before the delivery date.

No outside computer time was needed for file conversion efforts. The initial configuration called for one seven-track tape drive. The drive was attached for the first four months. During that time, the input to a 1401 job was placed on the seven-track drive the first time it was run under compatibility. This procedure allowed time for all input files to be "converted" during normal production runs.

Standard procedures were used with the 1401 operations. They were updated before the 360 order to insure that the configuration, operating system and intended direction were consistent. Since training sessions began the in-house standard procedures manual has been constantly updated. In relation to the documentation aspect of standards, the self-documenting features of COBOL have been deemed adequate.

Although no part of the original conversion plan, some of the programs initially operated under compatibility mode have since been changed. As need developed for expanded insurance processing concepts some of the old systems were extensively redesigned for 360 based operations.

Interestingly, user involvement was not included in the conversion to 360. A planned major change, however, begins from concentrated training efforts directed first toward middle managers and then toward the direct contact users under them. Detailed development and scheduling of the new approach to EDP for the company will proceed only after the initial education program is completed.

Case 20

Intentions to move gradually into third generation computer usage by Insurance Company 6 were abruptly redirected when a merger was announced. The lead programmer had planned to attend all manufacturer schools available during the first three months of the year. The information gained was to provide a basis for evaluation of various features and characceristics to be considered on order negotiations and later to planning toward an actual conversion two years hence. The various facets were to be worked slowly into place, relying partially on previous experiences of others. Just as the classes were to begin, a merger was proclaimed which eventually sent shock waves throughout the organization, especially the data processing staff. Sudden alterations were made to equipment, orientation procedures, data processing priorities, and staff.

Merger plans called for Insurance Company 6 to take over the operations of the other insurance company. The 360 which the other firm had was to be moved to Insurance Company 6's facilities within two months. Quick effort was required to make adequate preparations for the incoming equipment. Fortunately, the only changes which were required immediately involved floor space reallocations. The 360 and Insurance Company 6's own 1401 would have to share facilities until the 1401 programs were put into operation on the 360. The situation forced a hasty evaluation of the unit record gear on hand to eliminate the unused equipment and provide additional space. The computer room remained crowded until the 1401 was released, five months after the 360 was moved in.

Plans for systematic and gradual orientation of 360 operating systems and languages had to be dropped. Instead of sending the lead programmer to classes for exploratory purposes, the data processing manager spent concentrated extra hours reading manuals and working through PI courses. There was no time for outside training.

Data processing priorities were shifted to concentrate on two facets. In order to gain consistency, a conversion had to occur to bring the two companies under the same computer operations. The goal was to convert the other company's work to the 62COF adaptation used by Insurance Company 6. The change, by law, had to be completed January 1, or nine months after the two data processing operations came under one roof. Staffing problems further multiplied the complexity of this aspect of the conversion.

The second major phase was to get 1401 operations on the 360 as soon as possible. No attempt would be made to do any programs in native

mode languages. All developmental efforts were ceased until the two phases of the conversion were completed. Parts of three different Compatibility Operating System releases were used to obtain one meeting Insurance Company 6's requirements. All programs in the company's library were investigated extensively to locate input-output assignments and the changes necessary to allow operation under COS. The information was also used to develop the necessary control cards. There was no real deadline for the change to COS operations. Not having a firm date probably led to the fact that the project did not go as smoothly nor as quickly as was hoped. Some of the difficulties were directly traced to operators who did not understand the operating system and to programmers who did not investigate the 1401 programs thoroughly enough. The 1401 changeover phase of the conversion was completed five months after the 360 moved in. From that point until the legal merger date for combined processing, Insurance Company 6's operations ran under COS and were completely separated from the other firm's programs which ran under two different operating systems.

Completing the combination of the two companies' records was more critical, and more thoroughly thought out than the COS phase. Two months of parallel operations needed to be finished before the actual merger of the files and processing sequences could be accomplished. September 1 was set as the target date for preparing the firm's systems for 62CFO. A dry run of the actual merger-conversion process was held in September. A sample of the records which would be involved were processed to provide basis for the real merger. Errors found in the dry run were corrected. The run time of the test was used to

estimate the time needed for the actual conversion. Outside time was leased so the entire conversion of data files could occur without a break in the daily processing sequences. Manual efforts needed were noted and completed later. Eight additional months of work was put in before the single processing cycle for both firms was operating smoothly.

The merger affected the personnel of both firms. Those of the other firm were offered positions with Insurance Company 6 in the data processing and other departments. None of the data processing staff accepted the opportunity to move. All but the data processing manager of Insurance Company 6 left within six months of the actual merger. The drastic staff loss was attributed to widespread uncertainty concerning job security throughout the company. Such a tremendous loss of personnel added a greater degree of urgency to completion of the conversion and merger aspects for the data processing department. To avoid in-house trainee efforts and in view of the general lack of experienced people, trade schools were relied upon as a source of programmers. The resulting staff had no one with programming experience of more than six months. Many were limited to trade school training in System 360 only. The operations side of the picture was not quite as bleak. Three experienced operators were located and hired. An operating systems specialist was also located and the new position was added.

The conversion provided a convenient time to split key-punch and operations from the programming and systems group, placing each under a separate manager. Formal programming and operating standards evolved out of the urgency of the total situation. The merger deadlines coupled with lack of experience required that standards be developed and enforced.

Considerable training efforts were necessary for users. The loss of personnel outside data processing meant great numbers of individuals involved with 62CFO input and output were unfamiliar with the system. The complications in finishing strictly the data processing part of the project meant much of the training occurred after the processing systems of the two firms had been merged.

Case 21

Insurance Company 7 ordered a 360 when the System was announced and took delivery in August, 1966. Actions taken with regard to the conversion were recorded and kept for future reference. Prior to installation, efforts were undertaken and completed in regard to software changes, training, and facilities preparation.

Emulation was the route chosen for the company's 1401 program. None of the programs was to be changed to native 360 mode operations for the immediate conversion, nor were plans made to change them at a later date. The approach was basically the same as that taken for the firm's conversion from first to second generation equipment. Unit record processes were merely moved to the 1401. Following the initial change to the 1401, programs were added but the original unit record operations were not upgraded. The result is that the unit record jobs were ultimately transferred to the 360 with no change. No new programs were prepared for native mode operation on the 360 in advance of the equipment. Implementation of them would have necessarily been delayed until well after installation as there was no test time available as outside locations.

EDP staff members were introduced to basic 360 concepts in advance of the equipment delivery. Both programmers and operators were phased into manufacturer classes at the data center. The main purpose was to prepare them to function under compatibility mode operations. Operators received further training after the equipment was installed. A Systems Engineer spent the first week working directly with them on the job and in modified class sessions.

Detailed plans were made for the facilities changes necessary to bring in the new equipment. A new room was designed and built on the ground floor for ease of equipment movement. Special features such as raised flooring, increased air conditioning, etc., were provided in compliance with equipment specifications. Customer Engineers and the company's own building crews were consulted. The facilities were completed a month before the delivery date as scheduled.

Within ten days of the installation of the equipment, the 1401 was released. All the previous operations were functioning under the compatibility feature. Maintenance was carried on as before the equipment change; 1401 languages and individual changes to the programs were made when needed. New programs were written after the changeover in FORTRAN according to an earlier decision. It was felt that the FORTRAN language would allow outside processing on lease time regardless of the equipment when such an arrangement became necessary.

Some two and one-half years after installation of the 360, a new data processing manager was hired. The result was a prominent change of direction in the systems and software approaches taken. Work was undertaken to phase out all of the old programs, based on management need priorities. Elimination of the first generation unit records approach

became an immediate goal. All programs not worth salvaging were entirely reanalyzed--many to the extent that the previous programs were not even referred to in forming a new system. Redesign efforts included analysis in two directions: EDP and user. Strictly EDP-based evaluations were conducted to improve throughput and move toward the total systems concept. User analysis efforts helped combine needs and increased comprehensiveness in the scope of the systems developed.

Case 22

PERT scheduling techniques were applied by Insurance Company 8 to coordinate conversion preparation activities. Data processing activities had been scheduled and carried out for some time with the use of a computer-based PERT system. The conversion was viewed no differently than other projects, except for the significantly greater number of steps involved. Physical planning, conversion of programs, and schooling were the primary areas detailed for the PERT networks. Weekly updates were reviewed with the people responsible for actually completing each phase. The PERT technique served as a tool to review the status of the conversion processes. It also helped in reallocation of resources during the procedure in effort to keep on target.

Many decisions preceeded development of the PERT completion schedule. At the time System 360 was announced, Insurance Company 8 foresaw extensive use of teleprocessing as advantageous to its own operations. The equipment was ordered right away, with the ultimate commitment to teleprocessing in mind. More detailed feasibility studies followed to determine exact configuration specifications and the appropriate software route. The data processing department managers went to 360 classes as

a part of the study. The classes gave a basis for decisions on the operating system and programming language desired in addition to emulation and simulation features for many of the programs and systems in current operation. The decisions reflected in-house capabilities as well as future goals and applications.

A brief look into the firm's history with data processing will help explain some of the critical decisions. A daily processing cycle to handle life insurance polities was conceived in 1957. A complex network of problems was operational by 1960 on an 850 tape system. The system was similar to 62CFO; however, it was a one run concept, not a series of small jobs. Increased volume and the fact that the vacuum tube machinery was wearing out forced the issue of alternate equipment. A 1410 was ordered as an interim machine just before the official announcement of the 360. The 650 program was simulated for the most part on the 1410. The daily cycle processing time was cut in half as the volume runs were reprogrammed into 1410 native mode languages. The equipment provided enough extra time that new systems could be developed and implemented. The 1410 also provided COBOL language capabilities, which were used as a training aid once the 360 decisions were firmly made. The complexity of much of the daily processing cycle meant that rewriting and redesigning at one time were to be avoided. Simulation and emulation capabilities on the 360 provided the means to put off the work until excessive program maintenance provided the excuse for redesign.

Another factor significantly affected Insurance Company 8's conversion to third generation equipment. The company was selected as a monitor firm for development of an insurance processing package in 1965.

The package was to be designed for use on System 360 equipment. As a monitor company, Insurance Company 8 helped design and write parts of the package. Remembering that the monitor work began two years before the firm's own 360 was scheduled for delivery, the assignment served as a means of getting some of their own requirements into the package, which they would ultimately implement anyway. A side benefit was the practical "advance" training opportunity the position provided.

The basic decisions and supporting events, as described, contributed to actual development of the PERT schedules for completion of the conversion. As many individual steps as possible were set out for each of the major phases, with estimated completion times assigned to them. In the area of physical site preparation, dates were established for wiring, enlarging the room, constructing the false floor, and approving the equipment layout. The various steps in each of the areas were further detailed. In relation to conversion of programs, requirements were detailed concerning data gathering, clerical type file changes, and new program schedules. Schooling aspects were also subjected to PERT scheduling. Operators and programmers were phased into necessary classes. Time was provided for user training in new systems. The data processing manager's view, after the fact, is that the schedules, while not met, helped guide the entire project. If anything, an even finer detailing of the steps involved would have provided a more accurate picture.

The 360 signaled initiation of two new features for EDP operations at Insurance Company 8. Both are related to standards. The most significant was the development of an Implementation Group. The group

handled user training for all new and changed systems, and worked with the users during the implementation phases. The Implementation Group was itself trained by the programmers who were responsible for helping to write manuals and procedures when training of outside users was necessary. The second development related to standards in a changing environment. Growth of the staff and turnover necessitated more completely developed documentation for EDP use. Rigorous patterns were to be met to provide maintenance programmers and operations with information essential to complete their tasks.

Case 23

Careful volume and space records indicated to Insurance Company 9 that it would soon run out of room on its 1401 disk system. The space problem coupled with a desire to upgrade and add extensively revised systems led to placing an order for a 360 early in 1965. There was adequate time for detailed usage planning as delivery was not expected for eighteen months.

Two paths were open for the upgrading project in mind: the Company could either write its own system or use the ALIS package. The tendency was toward development of an internal system. ALIS, a life insurance processing package for use on System 360 equipment, was in early developmental stages. A prospective customer class was held in October, 1965, to alert users to what to expect from the comprehensive ALIS system. Insurance Company 9 chose to go with ALIS, although completion of the system was an indefinite future date. The decision did not mean the delivery date of the 360 equipment would be postponed. It meant that two delivery dates, equipment and ALIS, would shape work done by the firm.

The delivery date provided the target date for completing work on new facilities, programmer-analyst training, and emulation preparation. A new addition to the firm's building was designed for the computer and the data processing staff. The staff members moved into their new offices a month before the machine arrived. Because operator training was done onsite and on the job, the concern was in preparing the programmer analysts for 360 compatibility and native mode operations.

The staff was not large, and arrangements were made for both manufacturer directed and PI courses. The immediate benefit of the courses resulted in changes to the 1401 processing scheme for more efficient processing under compatibility. Programs were written to change the basic input to tape rather than cards which fed each 1401 program. Extra special attention was given to converting the files on the 1405 Ramax disk which was attached to the 1401. The process involved punching cards for each record on the 1405 and reading all the cards onto the 360 disk files. There was no other means of performing the dump. Timing was particularly critical to insure no processing cycles were lost and that no duplication of processing was necessary. Once the data files were converted, operation under compatibility began; the 1401 was never used again.

The equipment change-over signaled the beginning of more concentrated efforts directed toward the ALIS phase of the conversion. Programming in 1401 languages was stopped. One programmer was assigned to maintenance work on the programs operating under compatibility. The rest were assigned to strictly 360 projects. The 360 projects were prepared to use output from the ALIS system. While no formal documentation

of ALIS was yet available, the output format was fairly definite. Insurance Company 9 designed and wrote special features that it wanted to supplement ALIS as there was time available. The necessary work was actually finished a year before the ALIS package was available.

Documentation and program tapes for the 2000 program system were available in their initial form in October, 1968. The data processing manager had attended schools in advance of the release. Once the 54 volume documentation was on hand, the data processing manager set to work editing and reorganizing the many volumes into meaningful sections for various user groups within the company. Education manuals and reference guides were also prepared. An eleven-month schedule was drawn up showing education, analysis, coding, writing, testing, logic consistency checks, and final conversion efforts. (See attached)

The small EDP staff and the wide reaching implications of the system made it necessary to plan and carefully check the many aspects involved. The final test and data file conversion were postponed to allow year-end activities to be completed under the old system before the actual change-over. The file conversion portion of the project took fifty-two hours over a weekend and included time leased from two other 360 installations. Time was provided for error checking, correction, editing, merging, and testing the converted files.

The ALIS system had wide implications throughout the firm. To insure that each knew and understood his role and the system, numerous classes were held by the data processing manager. Each user's part was tested as the project moved toward completion. The tests included the user's role to teach him about the atmosphere of the system. Training was continued after implementation to handle problems. Seminars were

ALIS CONVERSION PLAN

MONTH										
1	2	3	4	5	6	7	8	9	10	11
Form Steering Committee Make Assignments			Education of Supervisors			Company wide Education				
	Analyze, write, test Special Conversion Programs					Create Master Record				
	Create Test Data	Test Insurance Logic								
			Modify ALIS to own Specs.							
		Design, Code, Test Special Routine 1								
		Analyze Output for Mo.								
			Design, Code and Test Special Routines 2-5							
			Analyze & Create Special data file							
						Final Test Special Routines				
			Research Executive Operating Procedures needed				Modify Exec. Proceeding			
							TEST	Final Test File Conversion Implement		

held with different users as their experiences with the system increased. Classes are held periodically for new employees. One of the results of implementing ALIS has been a reorganization of the firm's functions, outside the data processing department. The organization is reshaping around ALIS.

Insurance Company 9 did not consider its conversion to third generation really complete until ALIS was installed and running, three and one-half years after the 360 equipment arrived. In fact, by including the extensive post-installation training which was included, the conversion process took even longer. Doing the job thoroughly was the key to the process.

Case 24

High level planning and extensive training are the notable characteristics of the conversion experienced by Insurance Company 10. The entire process was under the direction of the home office and encompassed a number of individual conversions. Every employee was exposed to some degree of orientation or training in relation to the conversion. This was a key element in the success of the major change.

Nearly every aspect of the conversion was under the direction of the home office. Specially designed second generation equipment became inadequate for the general processing needs and the expanded systems planned for the company. Arrangements were made for periodic delivery of third generation equipment to the firm's data processing centers, to follow the delivery of the home office's own equipment by at least two years. During the interim, the systems in operation were almost totally redesigned. The only element that did not change was the reports produced;

their number increased, but the old ones did not change. Processing was changed from a weekly to a daily cycle. Six months of home office testing was undergone before the local conversions were started. Each local conversion involved the entire set of systems to be implemented.

Individual conversions were scheduled two years in advance of the event, subject to home office change. The detailed schedules for equipment, testing, file conversion, and training included written statements of the basic system requirements. The 360 equipment was to arrive three to four months before the conversion of operations was to take place. Prior to delivery, the individual data processing centers had received equipment layouts and the things needed to prepare the computer site, such as new flooring components, etc. The time between installation and production operation of the new equipment was completely devoted to testing. Various test data and tapes were developed and supplied for the procedure by the home office. The extensive test period and activities served double duty as checking out for the equipment and procedures and as on the job training for the operators.

The last step before changing over completely was to convert all the data files to the new formats and equipment requirements. All records involved were sent on tape to the home office for processing. Special equipment had been designed to handle the data conversions necessary. The timing was critical so as not to interrupt data processing activity. The converted files, the company's systems tape, and the operating system tape were returned to the local office and dumped onto the proper disks.

Two conversion teams assisted the individual installations before and during the conversion. A technical group was present during the two

weeks preceeding the conversion. Its job was to direct the actual changeover and handle any technical problems arising with the equipment, data, and systems involved. The group's work was over with the first production run of the new system. A second team functioned throughout the time preceeding production operation. It came in periodically beginning with installation of the equipment to check on the progress being made and to assist with training procedures.

Although the data processing manager and selected other local personnel were involved in orientation and had considerable correspondence from the beginning, the real local education process began six months before the change-over. Written documents and class sessions were used. On the technical side, an operating manual and a systems manual were prepared by the home office for the data processing staff. Elements of the manual were broken down and prepared for each user, covering those aspects of concern to him. Various class sessions were held for users and EDP personnel.

A lesson learned from the conversion to second generation provided the foundation of the philosophy applied: attitude and confidence throughout the organization determines the success or failure of a project. The conversion project involved every employee of the company, even if it was only indirectly through his computer produced pay check. In this over all respect, an orientation session was scheduled shortly before the conversion with all employees explaining the why's and wherefore's of the change. Users, input coders and others were prepared according to their roles in the operation of the system. They were taught to prepare and check new documents and to use new reports. Class sessions were supplemented by written documents and on-the-job training.

The data processing department received more comprehensive and technical education. The department is unique in that there are no local programmers or systems analysts; all of that work is performed in the home office. A new position, rather like an in-house systems engineer, was created. This individual handles operating system and internal company systems changes and updates, and acts as a liaison with the home office EDP group. He and the data processing manager attended extensive manufacturer courses as well as a six week class conducted at the home office. These two, with conversion team assistance, were responsible for in-house training of operators and key-punch operators. Computer operators also attended basic manufacturer courses as a part of their education program.

Support from the top down and extensive communications were the key factors leading to a successful conversion effort. The conversion was a company-wide project. Home office support was directed department by department throughout the organization. All levels of personnel were included in correspondence on the new system. Training and building confidence were as important as the technical EDP work.

Miscellaneous Cases

This section contains cases concerning four firms which might normally be considered primarily scientific data processing users. All presented here use their computers more for commercial applications, and were most concerned with the commercial aspects of the conversion. The two petroleum companies were particularly emphatic about training their data processing staffs in the basics of the industry before learning EDP skills. Another firm handles engineering services.

The remaining firm is a conglomerate and represents a situation of replacing many diverse computer installations with a central processing concept. Teleprocessing was the basis for the third generation installation.

Case 25

Three years before installing third generation equipment, Petroleum Company 1 began considering the necessity of conversion. Its 1401 card system was running twenty-four hors a day, seven days a week; cards were everywhere. The computer operation was completely saturated. The computer became unwieldy with a great volume of cards.

Various studies were carried out by two programmers, who along with the machine operators made up the whole data processing department. Their recommendations were presented to top management who, in turn, ordered the equipment and set target dates for conversion. The specific configuration of equipment ordered was not that recommended by the data processing people. A Mod 30 tape system was to be installed two years following the order.

While there were two years available for conversion preparations following the order, most of the work was done during the last year. Preparations included increasing the size of the data processing staff, training the staff, changing the applications for the 360, developing standards, preparing the facilities, testing, and training users.

As mentioned, there were but two programmers on the data processing staff at the time of the order. The programmers handled all of the data processing functions, including operations when it was necessary. A real EDP department began to take shape. In anticipation of

the new equipment, operations, programming, and systems became distinct functions. One of the original programmers became the data processing manager as the department was expanded. Relative to the staff build-up, it is important to note that top management did not understand the wage factors of the data processing industry at that time. The mediocre salaries they offered in 1966 and 1967 attracted mediocre talent. Obtaining good people was impossible, and non-experience became a big factor. For instance, the first priority was to locate a systems analyst, eighteen months before installation. Salary limits forced the hiring of a generalist who was not really concerned with computer applications; he had no experience with computer systems. A second "systems analyst" was added six months before installation. A special problem arose in relation to the programmers added. With any experience at all, the programmers were able to go elsewhere for more pay. High turnover led to an average staff of seven programmers during the year preceeding installation. There was a continuous problem of training inexperienced people. A good deal of time was spent as the original data processing staff tried to relate to those they were able to hire. These factors led to timing problems related to the target conversion dates set by company management, even though all worked considerable amounts of overtime.

Training for the new systems and programming personnel was done in three main segments. The first step insured that they understood basic facts and terms related directly to the oil and gas industries. Company-designed manuals were used for orientation purposes. The next step included the manufacturer's language schools and basic operation

experience. Language training concentrated on COBOL. The data processing manager felt it essential for all of his staff to be somewhat familiar with the "black box," so basic operations experience was included for everyone, although programmers and systems people do not act as machine operators. Exceptionally beneficial elements were noted during the initial training sessions and have been included in refresher sessions which all data processing personnel now go through periodically. The last step of the original conversion training was on the job with the help of the Systems Engineer, primarily after the machine was installed. Operator training was limited to in-house orientation meetings and systems testing.

Plans for conversion of the 1401 applications were done "road-map" style. The data processing manager indicated the target dates were based on freehand guesses. Because not all factors were considered and major changes were made during the conversion process, the originally estimated completion date was not met. Changes frequently occurred during the individual projects which meant changing all the work which had preceeded.

The conceptual design of the systems for the 360 was completed a year ahead of installation and as the programmers were being hired and trained. The change essentially was from the card based 1401 systems, to systems for the Mod 30's Tape Operating System. There were no disks on the System 360 to be delivered. The design of the 1401 applications greatly influenced the designs developed for the same applications on the 360, although only ten per cent was limited to recoding. Target dates were developed for various areas according to a priority

sequencing of the systems. Within each system, individual segments were developed as completely as possible before interface with other segments was required. The target dates developed include consideration of vacation time, absence, programmer and systems ability, and user involvement. Evaluation of the actual completion dates showed that major factors had been completely overlooked. No consideration had been given to the volumes of data per application. Although needs and desires of users had been included, many had not been included to a sufficient degree. The specific software conversion aspects included file conversions from card to tape. New data formats, card formats, printer layouts and the like were considered.

Although the entire conversion period was eight months longer than anticipated, considerable work was completed even before installation. A case in point is the payroll system. The system was completed, checked-out, and operating well before installation. Time was leased on an outside Mod 30 to run the payroll system for three months before in-house equipment was available. The comprehensive testing completed prior to installation was significant and will be mentioned again.

The conversion presented an opportunity to formalize, improve and change standards relating to data processing activities. As the 1401 applications were designed and implemented by only two people, verbal standards were their main vehicle. The use of verbal standards carried over to initial experience during the conversion process, but some elements were developed for the new systems analysts and programmers. The experience factor and evolution of 360 usage led to writing, formally, the majority of the standards currently used. The same pattern of standards

development has occurred in relation to operators. However, written operations standards had been prepared for 1401 production. Early 360 operations were just the necessary changes to the old standards. A major operating change occurred as the company went to a closed-shop with the installation of the 360. The need for keeping all but operations personnel out of the computer room had been noted with the 1401. Installation of the 360 provided a convenient time to enforce the concept.

No additional space was available for the new computer. Plans for adapting the 1401 room were suggested by the Customer Engineers. Increased power and air conditioning were available six months before installation. The only last minute work was installation of the raised floor, which could not be done until the 1401 was moved. The floor was laid during the twenty-four hours preceeding physical installation of the equipment.

A great deal of effort was directed toward testing the systems to be implemented on the 360. Ninety per cent of everything intended for conversion had been tested and proved off site before the company had its own 360. The testing was done at the data center and during time leased from other users. The idea was to locate programming and systems errors as well as to provide user and operator training. Dry-run testing was done primarily after installation. The dry runs included all user contact with input and output. Operators were given a chance to become accustomed to the new equipment and to the scheduling factors involved with the new systems. Systems were implemented as their elements were completed and successfully tested through the entire process. Formal user instructions for the new systems were

written by the programmer and the systems analyst was involved, as they worked with the user in perfecting the system--from definition through testing.

The in-house testing and work on few programs done before installation became increasingly bogged down as systems were implemented on the new equipment. As the number of systems in operation increased, it became apparent that the equipment configuration was inadequate to handle the volume of work processed by the company. The result: management changed its mind in the midst of an initial in-house conversion effort. Disk drives and Disk Operating System were ordered, upgrading the computer system a year after the initial installation. The TOS systems quickly took all of the processing time available. DOS provided the opportunity to increase processing time and increase throughput. At the same time there would be run-time available for development of the many requested new systems. In turn the change to DOS involved many changes to the 360 systems, which had been previously implemented, in order to take advantage of the disk capabilities. The major change of peripheral equipment meant conversion was not completed until after the intended date, a total of fourteen months after installation.

In summary, three main factors affected the conversion process. One was the reliance on 1401 card based systems design. The ideas were carried over to the 360, causing it to be used essentially as a fast card machine, once card-to-tape operations were completed. Input had not been significantly altered, and was more card oriented than necessary. The over-emphasis on "old" type systems design was partly due to the managerial control of the equipment order. The second factor, low

salary scale, was responsible for both delays and mediocre work in systems and programming. The third main factor affecting the overall conversion, was managerial realization that disk and DOS facilities were necessary--after TOS had been installed and used as the basis for the company's application.

Case 26

Petroleum Company 2 experienced an early conversion to third generation. Its 360, Models 30 and 40 were installed in June, 1966. The conversion took two and one-half years and was completed eighteen months after installation. The new machines replaced a 1401 and a slightly more sophisticated 1410 tape system.

Concentrated preparation for the conversion began a year in advance of the equipment. Software plans were developed, programmers were formally trained, programming efforts were started, the operations staff was increased, and some testing was possible before the equipment arrived. The plan covered three main phases for software conversion. The first two phases overlap and really signified the intended conversion. The emulation phase was a vehicle allowing all programs not recoded prior to installation to be run as they were on the new equipment. The second phase was to recode all 1401 and 1410 programs as they were to get them into native 360 mode languages.

Rewrite efforts were started a year before the machine arrived. The primary concern was to run in 360 mode, taking advantage of increased speed. The order in which the programs were rewritten was based on an analysis of user reports per department. One system was discovered to take up ninety per cent of the processing volume and was the first to

be rewritten; it was a majority of the library. Another system produced a significant volume of vital output, and it became second in priority. All remaining programs were done as the opportunity arose, in no specific order. The two years following installation were allowed to complete the software conversion process. In actuality, the procedure went faster than anticipated. The emulation feature cut previous production run time in half, a pleasant surprise. The result was that a great deal more test time was available than had been anticipated. Phase two was completed six months ahead of schedule.

Phase three, while included in the long-range conversion plan, was not essential to considering operations fully converted to 360 mode operations in the eyes of the firm. Redesign of all systems was to begin as there was time, and to proceed at a steady pace until they were completed. Work on redesign began shortly after installation. All the systems had been implemented by mid-1970, after a four-year span. Much of the redesign work included the addition of disk capabilities to the tape bound 360's the company had.

Training among programmers began with schools attended by the Programming Manager. From his experience, specific classes were selected for the others. Programmers attended classes one at a time. In a staff of four, two went early and began recoding efforts. The others attended classes nearer delivery time and carried out maintenance work on the 1401 and 1410 programs. Once the machine was installed, the presence of an S.E. for the entire first year contributed well to on-the-job training and guidance.

Computer operators also attended manufacturer schools. The operations staff increased from two to five, just prior to installation. An

operations supervisor with 360 experience was hired from outside. He acted both as a supervisor and a lead operator during initial stages. His experience served as a sound basis for on-the-job operations training for the staff.

Pre-installation test time was primarily allocated to procedures programs. These programs are the type that serve numerous applications programs as a sort of in-house standard "software package." Because so many other programs depended on the availability of these standard routines, it was essential to have them completed and operational before the others. Data center time limits and the dependency upon the procedures programs meant they received the majority of the test time available prior to installation.

The recode approach of phase two eliminated any necessity to involve user or supporting departments in the change. No changes were made to any input, output or key punch forms. These changes were, however, made during the redesign phase. The only physical changes made followed installation of the 360's and were not necessarily related to the equipment. Increased volume and work load led to increasing keypunch and programming staff space allocations and to the addition of a tape library.

Target dates were met early because sufficient time was allowed to convert fully, according to the intended scope of software conversion, i.e., recode. The data processing manager and his staff knew the job via experience, not documentation. The documentation of in-house systems has not come about until very recently. It must be noted that the data processing manager felt the early completion was, to some extent, due to luck. There was no real control of the conversion process, in the sense

of following up activity and checking on critical phase completion. The experience factor, thorough and detailed understanding of company data processing activity, appears to be the overriding element.

Case 27

Engineering Company 1 joined the 360 band wagon right away. Its 360 was ordered within three weeks of the official announcement. Increased storage, faster processing, faster disks, and decisions by others to change, led to the order placement. Its Model 360 was also one of the earliest received by anyone. Delivery was taken in May, 1966.

The first decisions made to facilitate the conversion involved the language and the initial approach to use. RPG was chosen as the primary programming language, and assembly language for necessary support routines. The languages were to be the vehicle used for getting the 1401 programs into 360 native mode. The Compatability Operating System, however, was to be used extensively until programs were thoroughly ready for implementation. These decisions provided a basis for determining more definite procedures to be followed to complete conversion. To the firm, the completed conversion occurred when all the 1401 programs were operating in native mode 360 languages.

"Blue sky" sessions were held to set out the conversion path with the top two data processing managers and a Systems Engineer. Several days of sessions were held sifting through ideas, setting priorities, etc. More thought was given to the idea of systems analysis and how it would be used to help develop 360 applications. Priorities were then assigned to the existing 1401 systems, and detailed inventories

were prepared for each project. Comparisons were made to theorize on what the data files should ideally be in comparison to what they really were on the 1401. The study included file organization, rearrangement and combination of information, inclusion of new data, and consideration of new input formats to provide the desired result. Systems analysts were to work closely with the manager of each user department during redesign. Allowances were made for conversion test time. Consideration was given to what was involved, the tools needed, and the best time for conversion of a specific system. Schedules were worked out, estimating that the software conversion would be completed within a year and one-half of delivery.

Fortunately, the company was in the planning stages of adding on a considerable amount of floor space at the same time initial preparations were being made for the conversion. Customer Engineers were able to work directly with the architects in preparation of the new site. It was a handy coincidence that brand new physical computer facilities were constructed well in advance of installation.

Formal training sessions were held for some of the programmers and all of the operators prior to installation. Those programmers free to begin analysis and programming for the conversion were sent to schools, one at a time, beginning six months before installation. Very few people had any working knowledge of the 360 at the time, and instruction was based on the manuals rather than practical know-how. Once the Mod 30 was in-house, however, S.E.'s provided many greatly needed answers and research. The operators attended a one day training session just prior to installation. Informal help was derived through membership in organizations like the Data Processing Management Association.

Many difficulties were encountered in learning to use the new programming languages and the operating system. The troubles were prevalent throughout the first year of operation. Inexperience and system bugs led to most of the operating system woes. The primary language proved, after considerable work and testing, to be inadequate for the task. At that point, a change was made to COBOL. The language change led to delays and additional learning efforts, although it was not as difficult to comprehend as the initial language. Direct exposure to and work with the operating system eased the problems of learning the second language. By the time the change to COBOL was made, the staff had also developed an understanding of how systems should be developed for the 360. Until that point, not much thought had been directed toward making redesigned systems more 360 oriented. Changes in the programming language and basic system design approach and over-optimism delayed completion of the conversion process. It took four years, not one and one-half, as originally foreseen.

The data processing manager stressed that one probably cannot plan enough for a project like conversion. He would allow considerably more time were he to do it over. He also suggested developing courses of action for two extremes: the best possible situation, and the worst possible situation. Theoretically, if one had a good idea of what he would do in each extreme situation, plans and reactions to real events would be more realistic.

Case 28

The total effect of the conversion Conglomerate 1 experienced from second to third generation was a change from one working environment to another. The working environment was dramatically changed in

a short time span; it did not merely evolve as did many third generation working environments. The change was affected by organizational characteristics and by the needs of the firm and its varied subsidiaries.

Corporate management authorized a feasibility study encompassing its highly decentralized subsidiary data processing departments. The study revealed as many diversified approaches to data processing as there were industries represented. Everything from in-house and service bureau 1401 operations to unit records processing was represented. The final recommendation called for a central computer system with teleprocessing linkage for all subsidiaries and no provision for compatibility mode operation. The basic proposal was accepted, and those who did the study were hired permanently to carry out the recommendation. An order was placed for a 360, Model 40 to be delivered eighteen months later in August, 1966. The no-emulation feature of the proposal was not accepted and forced a complex problem. At the time there was no operating system feature allowing native mode and compatibility mode programs to run without halting the computer to initiate the required operating system. Clearly, under the diverse group of users and a teleprocessing environment, the situation complicated things.

The three members of the feasibility study group set out immediately to develop fully the standards and techniques manual begun during the feasibility study and to build an adequately trained staff. Each of the group worked most directly within his specialty, i.e., hardware, internals software, applications software development. The standards and techniques manual was recognized as key coordination and development element. It began to take shape during the feasibility study as various

critical factors came to light from the individual users' sides, the corporate view, and the computer specifications and limitations. The conversion effort and the ultimately developed operation environment were geared to the manual. The supervising group was determined to develop, enforce and re-evaluate standards and techniques for the onset. The re-evaluation phase was continuous. During pre-installation phases, in particular, the manual was constantly expanding and being updated. Only one major revision, however, has occurred throughout the computer facility's four year history. The reason for the revision will be explained more fully later. Enforcement of the standards is an inherent element of the third generation facility which emerged. The firm's internal software adaptations and the specific teleprocessing arrangement require adherence to the standards. Internal checks prohibit non-standard use.

Staff development took place on two levels: individual EDP departments, and computer center. Both the computer center and its staff were new concepts. Staff building took place to develop a systems design group and a programming group geared to the hardware configuration to be installed. The staffs of the individual data processing departments were increased only when necessary. The main effort of orientation on both levels was directed toward changing data processing concepts from card-based thinking to the vastly different approach of teleprocessing. Both central and individual staffs had to become accustomed to the strict form of standards employed. On both levels there were people who had been accustomed to different or non-existent standards. Resistance to the change was expected, as the benefit of hard line standards rarely becomes apparent to those restricted

by them in the beginning. The distance between the locations involved meant that there was a great deal of travel in order to present information as well as to gather information affecting the desired T.P. installation.

The computer was installed and the teleprocessing network for all the individual data processing departments was put into operation. As expected, the compatibility-native mode, halt and re-initiate problem complicated the change. Further complications developed as non-compatible approaches taken by the systems design and hardware data center groups came to light. The hardware group and programmers had a primarily scientific orientation. Limits inconsistent with commercial data processing were established in what had to be a commercial environment. The condition dictated that a more coordinated approach, from the top, had to be taken. A reorganization of the central data processing staff solved that problem. Operations then continued with the understanding that the computer center was to serve the individual user departments; it was not to be a development center for either hardware or software.

Solving the processing problems associated with the compatibility-native mode situation, took considerably longer. It was decided COS operations would have to be eliminated. A rigid set of standards, the major revision of the original standards and techniques manual, was put into operation for both the controlling TP software and the systems to be converted. A task force of data center and individual EDP department people was established to complete conversion of the 1401 programs to 360 native mode. A translator program was used to assist with the essentially recode approach taken.

It was two years after installation of the equipment before the basic problems were ironed out and the teleprocessing based central computer operation was operating effectively. Throughout the process, the desires of individual processing units were balanced with corporate goals. Setting policies and standards through the manual, requiring adherence, and sticking to decisions were critical to changing the working environment and to correcting time-consuming problem areas which arose with the conversion process.