Proceedings of the Eastern Joint Computer Conference

Theme: Information Processing Systems—Reliability and Requirement

December 8-10, 1953

PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE

Theme: Information Processing Systems—Reliability and Requirement

PAPERS AND DISCUSSIONS PRESENTED AT THE JOINT IRE-AIEE-ACM COMPUTER CONFERENCE, WASHINGTON, D.C., DECEMBER 8-10, 1953

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Opening Address Joint Computer Conference

JOHN HOWARD†

IN THE AUDIENCE this morning are many visitors who have come from all over the United States—and from many other countries as well—to attend this conference. Your response has been most gratifying; and on behalf of the Joint Computer Committee, I wish to welcome you to its Third Annual Eastern Conference.

Washington is a particularly favorable location for this conference for three major reasons: First, since it is one of the major computing centers in the country, it provides some unique opportunities for the inspection trips shown on page 9 of your program. Thanks to the co-operation of the cognizant agencies, this will be the first opportunity for many of us to visit these pioneer computer installations.

Second, Washington readily furnished the enthusiastic and capable leadership required to manage a conference of this magnitude.

In this connection, I would like to have you refer to page 10 of your program, which shows the membership of the Local Arrangement and Technical Program Committees. I will not read all their names but wish to give special mention to Mark Swanson. He has done an outstanding job in guiding the management of the conference. Also, special mention should be made of Dr. Lewis of the Bell Telephone Laboratory and his Publication Committee who are responsible for the publication of the Conference Proceedings.

Finally, Washington is the home of a number of pioneers in the computer field. Many of them have never received the public recognition they deserve because of the classified or administrative nature of their work.

To these men we owe a real debt of gratitude for their early and continued support in the development of the data processing field. Many of these men are responsible for making policy decisions as to future courses of action to be taken —now that the field has reached its present state of development. Some of these decisions are momentous and will have a direct bearing on the security of the nation.

For this reason, I am particularly pleased to extend special welcome to them to attend this conference and exhibition so that they may hear first hand our presentation on a very important theme—"Information Processing Systems—Reliability and Requirements."

† Research Activity, Burroughs Corporation, Philadelphia, Pa.

Keynote Address

HOWARD T. ENGSTROM†

Introduction

I SPEAK TO YOU this morning as Chairman of the Technical Program Committee for the AIEE-IRE-ACM Joint Computer Conference. At the first of these conferences, in December 1951, at Philadelphia, a program was devoted to a description of existing electronic computers or those under development. The second conference, at New York, in December 1952, was devoted to a review of input-and-output equipment necessary for efficient usage of computer systems.

In considering subject matter for the 1953 joint conference, your Committee chose the theme "Information Processing Systems—Reliability and Requirements." Perhaps some explanation of this theme is in order.

I have been exposed to the rapidly developing art of large-scale digital computation since 1941. It appears to me that the art has gone through a series of phases. Prior to 1941, developments in electronic counters had reached a point where counting of electrical pulses could be carried out at megacycle speeds. The advent of World War II, and the pressure for making use of these high-speed units in military equipment, resulted in a series of developments which made possible supplying information to electronic accumulators at speeds commensurate with their rate of operation.

These developments included memory systems, notably the magnetic drum, electrostatic-storage tubes, and acoustic-delay lines. Although the perfection of these memories did not take place until after the war, basic developments were carried out during the war years. Fundamental work also was carried along in logical structure of computation devices and the command system.

The third phase of development in the art was that discussed at the conference of December 1952; namely, the input-and-output equipment which made possible communications from the memories and computing elements to the external world. Within the last two years, therefore, it is felt that the electronic-computing art has achieved maturity in that we now have well-balanced equipments. That is to say, we have high-speed arithmetic elements; we have a hierarchy of memories which can feed these arithmetic elements; we have peripheral equipment, such as magnetic tapes, high-speed printers, conversion equipment—which maintain contact between these memories and the external world.

This maturity of the art also applies to the industrial structure behind it. Shortly after World War II there appeared to be a lack of interest in the art by the larger companies who were probably most capable of advancing it. Many small companies were started on the basis of government contracts for specialized computers. Many such companies did not survive the financial problems. In the last two years, the interest of larger companies in this new field has been clearly demonstrated. Many of the smaller companies have been absorbed into these larger structures so that industry is now in a position to produce these equipments as rapidly as the demand for them increases.

It appears to me that the phase of the art into which we are now entering is that of applications. In applying these computers to many problems, questions of reliability and dependability have been repeatedly raised. Your Program Committee has therefore arranged this conference in essentially three parts. The first group of papers consists of statements of requirements in a variety of applications. Requirements in weather prediction form a typical case of scientific calculations. The use of electronic computers in the life insurance business is illustrative of many applications in the accounting area. Computer applications in air-traffic control problems are in an area in which reliability and performance may be a matter of life or death. The real time-control systems are illustrative of applications in the direction of complete automation.

The second part of the program is a series of papers giving actual performance characteristics of existing computers. These papers present results of operation, in many cases over a several year period, and since the papers are presented in general by those responsible for producing computational results, they should give a good indication of the success of existing computers in meeting requirements in reliability and performance.

The third series of papers is descriptive of work carried out during the past several years in connection with improving reliability of components and will provide valuable information from the position of component manufacturers in insuring the dependability of electronic-processing systems.

In closing, let me repeat that I firmly believe electronic information-processing equipment to have arrived at a state of maturity, and the next phase in the art is one of applications. Many of the advances in the field of applications will be made by the users of this equipment. It is gratifying to have reports from a variety of prospective users at this conference.

There are, of course, many applications to military problems which, for security reasons, cannot be discussed at this open conference. We had hoped to plan a classified session, but were unable to complete the arrangements. I am sure you are familiar with military applications, however, through individual relationships. It is hoped this conference will bring together information concerning reliability and requirements sufficient to answer questions of many prospective users.

I should like to express my appreciation to Mr. John Howard and his Joint Computer Committee for the parent organizations, for their great assistance in drawing up this program.

† Engineering Research Associates Div., Remington Rand. Inc., Arlington, Va.

The RETMA Support of the 1950 Computer Conference—A Progress Report

THOMAS H. BRIGGS†

IN ATTENDING the numerous technical conventions and symposia that are held each year, we listen to many learned papers. Problems important to our daily work are thoroughly discussed. Generally we return home with ideas that will forward our own engineering investigations. But we often find the problems discussed are larger than the individual or organization can handle. With mounting technical complexity, these problems are more frequently encountered.

The problem of tube reliability is of this nature. It is complex; it affects more than one industry. It causes us to say, "I wish someone would do something to improve reliability." During the past few years many groups were formed that effectively attacked the problem of reliability. Today, tubes are damned far less often, and the performance of electronic equipment has improved.

In December, 1950, a Conference on Electron Tubes for Computers was held at Atlantic City. It was sponsored jointly by the AIEE, the IRE, and the Panel on Electron Tubes of the R&DB. Over 300 engineers attended. The technical success of the conference was due in large meaure to: Dr. C. V. L. Smith, of the Office of Naval Research, Computer Section; Dr. A. L. Samuel, of IBM and the Panel on Electron Tubes; and Dr. Mina Rees, also of the Office of Naval Research. The papers defined problems and informed the audience about actions taken in individual situations.

As we left Atlantic City it was apparent that the Conference had been a real success. From every side one heard: "What can be done? This problem is too big for our laboratory." There was spontaneous demand that means be provided for co-ordinating effort leading to improved tube reliability for computer applications. The object of this paper is to show that action was taken, and how it has progressed during the three years past. We hope that as similar needs arise from this and future conferences that there may be stimulation to employ similar logical solutions.

The Radio-Electronics-Television Manufacturers Association was selected as a logical area for such an activity. It has been a basic plan of RETMA to encourage the study of standardization of components within special levels of refinements whenever such a need is shown, even though standards exist for the same basic components used in other applications.

In standardization, the initial studies are made by committees of engineers who are experts in that field. Therefore, for studying some special new class of components an entirely new group may be established. The story of activities in the field of electronic computers is typical of activities in promoting new products for a special class of equipment.

In May, 1951, after an organizing meeting was held under the auspices of the RETMA Engineering Department, the group decided that the electronic tube-reliability problems merited their undivided attention. Other components used in the computer field were left to other committees. Since the Joint Electron Tube Engineering Council (JETEC) is the agency that was set up by the two interested trade associations, RETMA and NEMA, to handle all problems relating to electron tubes, this Electronic Computer Committee was reassigned as a subcommittee of JETEC Committee JTC-5. This committee covers all receiver types of tubes. Thus the JTC-5.5 Sub-committee on Electronic Computer Tubes was created. Representation has consisted of tube producers, computer manufacturers, laboratories.

The problems apparent to JTC-5.5 at the start were:

1. To define reliability as required in the field of electronic computers.
2. To classify the special computer application needs, as they relate to tubes and crystals.
3. To determine the best test methods and the conditions to apply in making them.
4. To establish means for translating the conditions that are peculiar to computers into those that are useful to tube manufacturers for developing types especially suitable, and in controlling products.

The first concrete step was to prepare and distribute a lengthy questionnaire to all possible computer companies and laboratories. The gamut of questions were phrased to permit concise answers, generally of a "yes-no" nature. They concerned existing operating environmental conditions, types of tubes and crystals in preference of use, means for controlling and monitoring quality, and testing methods, all for use in this application.

An encouragingly high percentage of returns came back, well completed, for the major undertaking of correlation. These data were summarized and, in April 1952, were circulated to the participating groups for their information and use. All questionnaire returns were coded for maintenance of company anonymity with regard to answers.

† Formerly with Burroughs Adding Machine Corp., Philadelphia, Pa.; now Electronics Consultant, Norristown, Pa.

The answers indicated that several new tube-characteristic ratings were needed to define properly the tubes and the rectifier-type crystals required by the computer industry. To accomplish this, three task forces were set up to develop new formats for the JETEC Rating Sheets that were to be used in registering new tube and crystal designations for these applications; the three classifications were:

1. Crystal Diodes,
2. Twin-Triode Tubes,
3. Multi-grid Tubes developed for computer service.

The crystal diode format was brought to near completion and recently has been transferred to JTC Committee-14.2 for final acceptance and future use.

Following six draft stages the twin-triode format has just been submitted to JTC-5 for adoption. The multi-grid format required the submission of a second questionnaire to industry, but it too is nearing completion. Returns received during the summer of 1953 have been collated for study.

The new formats for tube ratings embody the previous information, but contain supplementary controls for plate current, cut-off characteristics, pulse ratings, plate-current balance between sections, contact potential limits, and several dependent criteria.

Normally, time-dependent criteria have not been admissible in establishing tube ratings. For more conventional usages tubes are considered interchangeable if they operate alike for relatively brief periods of time. However, it is the consensus of both tube and computer engineers that the definition for interchangeability in computers must include operation over a lengthy time. Thus, interface impedance build-up and heater failure with "on-off" voltage cycling for a particular tube can only be evaluated by studying those conditions over extended periods of time.

Incorporation of the time-dependent parameters as rating criteria poses many problems and technicalities. The actual method for specifying those factors is now under study.

Actions of JTC-5.5, or any committee in fact, must be predicated upon potential economic values. These two tube formats, when finally developed, will then be submitted for adoption by the RETMA and NEMA as regular JETEC Standards. The Tube companies can then employ the special data forms to supply ratings on the tubes generally used by the computer industry or when rerating tubes applicable for this service. The use of these formats is expected to provide ample economic return for the efforts expended.

Another major project on the agenda is the preparation of an Application Manual, directed to tube producers and to computer-design engineers. The reasons which lead to the format and rating decisions will be stated and means for applying the tubes most effectively will be pointed out. Interpretations of ratings, and means for determining the effects of unusual operation conditions will be included. It is expected that this manual will be of great use to component engineers and to circuit designers.

JTC-5.5 is cooperating with other groups in their work. Liaison is being established with JTC-5.3 concerning the establishment of a suitable method; capable of standardization, for determining *short-circuits*. This will require a rigorous definition of a short-circuit, relating such factors as time, resistance, and degree of tapping force. The causes of short-circuits, when they are intermittent and of extremely short duration, are extremely difficult to determine, and hence must be eliminated by accurate and standardized tests.

Co-ordination with the Cathode Committee of the American Society of Testing Materials—designated B4-VIII-A—has been established. Their work on development and standardization of a method and conditions for *interface impedance* testing is aided by interlocking memberships from the two groups. This problem is probably one of the most important confronting the electronic computer industry today.

So far, the work has been confined to digital-computer vacuum tubes. There have been requests to extend this both to gas-discharge tubes and to storage tubes. Extension of the scope of JTC-5.5 to include these tubes has recently received authorization from JETEC Council and these new problems now await handling time on the part of the working members.

The computer industry is far flung geographically. It is essential that the ideas of the entire industry be represented in the discussions of the Computer Tube Sub-Committee. Consequently, it is planned to establish a West Coast Coordination group. In this manner the results of our deliberations should have greater scope and authenticity. The tube manufacturers should be able to place greater dependability upon the recommendations from this joint tube producer-consumer sub-committee.

Initially JTC-5.5 concerned itself with germanium diodes as well as tubes. Obvious close relationship in use, as well as similar reliability objectives indicated a natural "junction." In the spring of 1953, cognizance of the diode crystals was transferred to the Committee on Solid State Devices. The program started in JTC-5.5 is being continued by JTC-14, under Mr. J. R. Flegal of Bell Telephone Laboratories.

JTC-5.5 Committee Membership

Mention has been made that this progress has been due to the co-ordinated efforts of the engineers of tube manufacturing companies and design engineers of computer equipment.

Chairmanship of the Sub-committee JTC-5.5 is alternated yearly between tube producers and computer equipment manufacturers. The first chairman was

Mr. J. A. Goetz of IBM. His energetic enthusiasm and organizing abilities gave the group an excellent initial momentum. In the second year, Mr. R. E. Higgs of RCA was appointed chairman, and capably extended the progress made in the first year. The Sub-committee JTC-5.5 is responsible to Committee JTC-5 on Receiving Tubes, and thereby is accorded major support and assistance through the latter's Chairman, Mr. C. E. Coon of the Tung-Sol Electric Company.

Other Components for Electronic Computer Equipment

As the progress of JTC-5.5 became effective and the difficulties experienced by the computer industry with tubes became better understood, improvements were announced. Other components in the circuit then became the centers of inquiry by RETMA Committees set up for this purpose. Most of these inquiries relate to Reliability matters.

A number of problems were mentioned, and so an RETMA committee designated G-2 (Computer Components) was recently established to cover the special needs of products in this field.

There are many items that have found applications in electronic computers. Those used in digital computers are, for the most part, common types of components, but precision, freedom from drift under unusual ambients or over extended periods with aging, constitute special considerations. Also there are a number of other components of a very special type used, especially in the analogue computer field.

The G-2 committee acts as a special co-ordinating group that determines what special problems need attention, and writes up a brief, outlining each of them. The Executive Council of the RETMA Engineering Department uses these briefs to set up new projects in the particular committees involved, or even authorizes the establishment of a new committee if an appropriate committee is not on the present roster. In each case the objectives are clearly outlined, but G-2 committee will provide supplementary suggestions when required by the committee handling a particular project.

The first of these G-2 sub-groups is G-2.1, concerned with Precision Potentiometers, under the chairmanship of Mr. J. R. Altieri of Technology Instruments Co.

Long ago RETMA established committees on such common components as resistors and condensers. Thus, outlines of special computer requirements for these components will be prepared by G-2 and submitted to these existing committees for study and action.

Another group of interest to this computer conference is G-3 on Magnetic Amplifiers under the chairmanship of Mr. E. V. Wier of Magnetics Incorporated.

Receiving tube manufacturers are located mainly on the East Coast. The computer industry, although young, has manufacturers and development laboratories scattered from coast-to-coast. Further, there are analogue as well as digital computers.

It is the desire of JTC-5.5 to have their results as authentic and as applicable to the entire computer field as is possible. Tube producers have found that there is a broad market for tubes that are specially-rated according to JTC formats. A number of tubes have been registered by the RETMA Data Bureau for use in computer circuits. Effective co-ordination of computer requirements will result in greater applicability of these formats. Extensive use of the format and availability of tubes meeting the listed requirements will thereby be accelerated.

JTC-5.5 has therefore inaugurated a new procedure to overcome the problem of geographical separation, and to increase the authenticity of its results. Arrangements have been made to establish a branch committee on the Pacific Coast. Agenda for meetings will be exchanged so that programs, discussions, and work may proceed in parallel. Through interchange of ideas, desires, and results, it is expected that progress will be on a broad front, and the results should be more widely employed. The tube manufacturers will have more certain data for tube ratings. The computer industry and groups with similar tube interests, will have even greater expectancy of achieving reliability.

In closing, I have no doubt but that this conference will serve to high-light its own problems on Information Processing Systems. I sincerely hope that you, too, may be stimulated to establishing working means which will lead to the solution, or at least the amelioration, of the new crop of challenging problems.

Discussion

R. L. Carmichael (Bell Telephone Laboratories): How are these committee reports and findings made available to industry? How does one keep abreast of the developments of the various committees?

Mr. Briggs: This is a problem which is of universal interest these days because every hotel you go to, on any trip, you always find a convention taking place and generally of a technical nature. On several committees of which I have been a member, it has been our attempt to sell to the membership that they should carry the gospel back to their home organizations. We have also attempted through personal papers, such as this one, to keep the general field abreast of what is going on in the technical committees. Most technical committees are very glad to have guests attending any of their meetings. JTEC 5.5 sub-committee meetings and their task force meetings, which is where the work is generally conducted, are well documented in the monthly notices put out by the RETMA office in New York. I would suggest that any of you who are interested should determine the membership representation in your company, and get them to keep you abreast or write to the RETMA headquarters should you desire to become a member of any of their committees.

The Use of Electronic Data Processing Systems in the Life Insurance Business

M. E. DAVIS†

(*Presented for Mr. Davis by J. J. Finelli*)

Introduction

IT WAS UNDER the impetus of the last war that several rapid computing devices were developed. They did very difficult and important mathematical work for the government and, in doing so, demonstrated a capacity to handle work similar to that found in many offices. It is not surprising, then, that at the end of the war some of us began to feel that machinery of this kind might be very useful in the life insurance business.

A relatively large amount of recordkeeping, computation, and analysis, is required in actuarial work. Naturally actuaries began to wonder whether such computers could be of assistance to them in developing insurance premiums, in mortality investigations and in other such activities. However, when an actuary tried to find out how to apply such equipment he quickly learned that life insurance people and electronic engineers were two groups who did not speak each other's language. He found the engineers quite willing and even anxious to have their ability and experience applied to the changes necessary to take computers out of purely laboratory work and into the business world, but they were lacking an adequate picture of the facilities the business world needs. On the other hand, actuaries and others in the life insurance field also lacked a sufficient understanding of the equipment which might reasonably be expected for insurance use. Some medium was necessary to bridge the gap between the two.

It would obviously be undesirable and unnecessary for each of us who might be able to use such equipment to start from scratch and separately begin to build up the knowledge needed. The preferable approach seemed to be through some joint effort. Accordingly, five years ago the Society of Actuaries appointed a committee[1] to examine into new recording means and computing devices and to report when it felt that such devices had been sufficiently developed that life insurance companies could consider their possible employment. Two such reports were made last year, one at the regular Spring Meeting of the Society of Actuaries in Washington, D. C., and another at a special meeting held in New York in September, 1952.

† Vice-President and Chief Actuary, Metropolitan Life Insurance Co., New York, N. Y.

[1] Committees were also appointed by the Life Office Management Association and by the Insurance Accounting and Statistical Association. Recently the British Institute of Actuaries also appointed a committee.

Studies by Committee of Society of Actuaries

The committee did a great deal of work in developing detailed procedures for applying electronic data processing systems to insurance operations. On the basis of the information acquired to date, it believes that systems suitable for day-to-day use are now available and that with such equipment substantial reductions in operating costs can be made. Further, it believes that the large potential of such devices will not appear clearly enough for practical purposes until some companies actually begin using them and make their experience generally available. A review of some of the many considerations and studies which produced these beliefs, and which led in at least one insurance company to a decision to contract for a magnetic tape system, may help to indicate the attitudes businessmen are likely to develop in considering the use of such equipment.

At the time of the appointment of the Committee of the Society of Actuaries there were no new systems actually available to business. Projected ideas which stemmed from laboratory use of computers like the Mark I, the Eniac and the Bell Relay Calculators, however, suggested quite strongly that corresponding equipment suitable for office use could be developed. The projected ideas were very good ones indeed—so good that even before the equipment became available, the committee tried to develop ways of using it.

First Approach

We started our studies by accepting, as a reasonable expectation, certain proposed plans for a magnetic tape computing system. With this visualized equipment as a starting point we tried to develop just what an average life insurance company might do with it to operate more efficiently. A very detailed operating plan for a hypothetical company was worked out on paper—but it did not supply a basis for any action. In effect, it said: "if a certain visualized magnetic tape system were brought into existence, it would make possible some radical changes in life insurance operation. These changes would greatly reduce the cost of current operations but it cannot be determined whether such changes can safely be made, how much they would save or when they would become possible." Needless to say with so many unknowns in the picture, there was little that could be done with this effort. Another approach was needed.

Second Approach

Several potential suppliers had been asking for a description of insurance practices. The thought was that, with a complete enough statement of current insurance practices, the suppliers would be able to design equipment especially suited to insurance work. Our committee felt that perhaps it might be useful to prepare a detailed statement of insurance procedures and make it generally available. This was tried. Much effort went into such an attempt but the project had to be abandoned because:

1. There is too great a difference between the practices, organizations and policies of the various companies to permit a description of general applicability.
2. It would be asking too much of an already burdened group of project engineers to require them to take on the formidable task of becoming sufficiently familiar with the insurance business.
3. It would be much easier for those of us who knew the insurance business and had a working familiarity with punched card techniques to develop the applications. The development of automatic procedures for the insurance business requires a deep insight into practices and objectives. It requires familiarity not only with the normal run of work but also with the variations and unusual circumstances which must be provided for.
4. Finally, it might be very misleading to supply indications of how work was now being done. There appeared to be good reasons for believing that substantial changes in current practices would be necessary to make effective use of the expected new equipment.

Third Approach

Out of this effort came the very strong notion that we have to avoid generalizations. Accordingly, it was decided that to be specific in indicating possibilities, we should confine ourselves to machinery already in existence and its possible effect in a particular company. This attitude led to a third approach which concentrated on the practices of one company. We first considered the manner in which a punched-card electronic computer could be used on certain work in order to establish a minimum standard for comparison. Then we visualized the manner in which a magnetic tape system might accommodate the same area of work. This effort resulted in development of a plan for administering life insurance policies suitable for use with several different electronic data-processing systems. This plan has become known as the Consolidated Functions Plan. A fairly complete description of it appears in publications of the Society of Actuaries.[2]

[2] In the Spring 1952 Transactions of the Society of Actuaries and in a report entitled "Report of Committee on New Recording Means and Computing Devices, September 1952." May be purchased from the Society of Actuaries.

Guide Posts

Perhaps the most important feature of this plan is the far-reaching change in current home office organizations and practices which it suggests. Principles behind this plan of general application may be stated as follows:

1. Apply the system to a whole job—not only to a departmentalized piece of it.
2. Combine small jobs with others to create the volume of work necessary to use the system efficiently.
3. Consolidate source records (i.e. combine files) so as to economize on the effort required to extract the data to be supplied to the system.
4. Perform all the work required from one handling of the data.
5. In devising the methods to be used, substitute arithmetical and logical operations for record look up, table look up and fact-recording operations as much as possible. Confine the information of record to the basic items. Avoid recording the associative ones which can be derived as needed.
6. Use a system in which sufficient checks have been included to avoid a cumbersome superstructure of clerical controls and error-correction routines.

It is to be expected that large economies in information handling would result from consolidating records and from combining work now done at different times and in different places. The plan emphasizes that such changes can be managed with equipment already in existence.

This, very briefly, covers the activities of the Society of Actuaries Committee. To date, at least three life insurance companies have arranged to acquire magnetic tape computers. One of them intends to use a magnetic tape system on some of its actuarial work. In addition, a fourth company is attempting to devise a comprehensive magnetic tape operating plan covering almost all phases of its policy service work. The idea is to test it on a small segment of the company's business and to extend it as the pilot operation becomes sufficiently effective.[3] Others are now investigating at the detail level, thus suggesting that some of them may be close to the acquisition of equipment of this kind.

Office Routines in the Life Insurance Field

There is no doubt that within the next few years there will be very substantial use of electronic devices in the insurance business. Accordingly, I believe it would be well to spend a few minutes discussing the various office routines required for insurance work.

Much of the work to be done in an insurance office arises out of the necessity to render service to policyholders. They are notified regularly of the premiums or benefits due. Upon request, adjustments and policy settlements are made as soon as possible. Many trans-

[3] A description of this plan appears in the Spring 1953 "Transactions of the Society of Actuaries," p. 198.

actions are handled each day by procedures which are very different in their details. In a broad sense, however, these procedures can be generalized by saying that each policy transaction to be dealt with involves some or all of the following steps:

1. The extraction of data from the information which initiates the transaction (a remittance, a letter, a notice of death, and so on).
2. The extraction of data from the information of record (as for example, reference to policy card files).
3. The use of extracted data to develop new information. (For example, putting data from (1) and (2) into a computer to determine a policy's cash value.)
4. The preparation of the documents required to execute the transaction. (The writing of checks, notices, statements, etc.)
5. The recording of the transaction in the record-keeping and accounting system.

When a policyholder changes his address, only steps (1) and (5) are necessary but when a policyholder requests his policy value in cash, all five steps must be applied. On certain regularly repetitive activities such as sending premium notices, the transactions are initiated by the company. Data processing systems appear to offer their greatest potential in the automatic performance of the operations required in step (3). Steps (4) and (5) are aided somewhat by such systems, but very little gain, if any, appears to be possible in steps (1) and (2).

To apply such procedures, a company must maintain a record of many facts for each policy on its books. In order to do this with clerical organizations, separate files and a separation of functions into manageable pieces is a necessity. In one company this involves keeping at least ten separate policy files spread throughout several departments. There are separate files for billing purposes, separate files for dividend purposes, separate files for policy loans, separate files for actuarial purposes and so on. The maintenance and extraction of the information of record is currently a fairly sizeable task because of the large number of separate files in existence and the many references being made to such files. This suggests that a way of keeping the record which permits automatic extraction—some random access device—would be very valuable. This may be, but it must also be kept in mind that procedures involving many separate files are not necessary with modern data processing systems. When such work is mechanized with automatic equipment, consolidation becomes indicated. There have been studies suggesting that perhaps as much as 80 per cent of the number of file references can be avoided by merging separate files and changing office procedures to a basis better suited to electronic systems. If such a reduction in the number of file references can first be arranged by consolidation, then a random access device (an automatic file) would be required to operate on only 20 per cent or so of the original work load. On such a substantially reduced volume, the appeal of automatic extraction appears to become very limited in so far as possible economy is concerned.

The preparation of statements, checks and other such documents represents another area of insurance activity for which high speed devices are currently receiving a great deal of attention. In one company a count was made of the number of checks, notices, statements and so on which are currently being prepared. This suggested that, while the inclusion of high speed printing in a data system would increase the savings possible, the size of the increase was relatively small. The need for separate printers of speeds very much higher than present punched card tabulator speeds is still a debatable proposition, at least as far as the insurance business is concerned.

Reference has already been made to a Consolidated Functions plan. I will not attempt to describe it here other than to say that, as previously indicated, it suggests a large reduction in the number of card files being kept and a combination of much work often done separately in different departments.

This plan, operated by punched card equipment, indicates roughly the potential possible short of introducing tape processing equipment into insurance operations. In one company, if it were operating on such a plan, estimates indicate that the cost of servicing insurance policies would split roughly 20 per cent for extraction (items (1) and (2) of the generalized procedure), 65 per cent for processing the data and recording the results in the recordkeeping and bookkeeping system (items (3) and (5)) and only 15 per cent for preparing documents. This suggests that substitution of a tape system would yield by far the most economy in the processing area with correspondingly small gains to be expected in filing and printing operations.

Magnetic Tape Files

Perhaps the most radical idea which business is being asked to accept is the idea that a reel of tape can safely be used to carry information now being entrusted to visual card files. Some of us have already accepted the use of magnetic tape as a processing tool. We have also accepted its use as a substitute for secondary card files but we cannot quite agree that, at present, it can safely be used to carry irreplaceable information now being recorded on primary card files. The adequacy of tape for this purpose has not yet been sufficiently demonstrated.

We are not quite sure that the tapes now in use or being tested are sufficiently safe from accidental erasure, loss of information through breakage, kinks, dimensional instability, flaking, and other such occurrences. Nor have we been satisfied that the devices currently being employed to read and write on magnetic tape can be relied on to do so with accuracy. While the error rate is

undoubtedly very small with such devices, the exposure to such errors is tremendously increased when it is realized that the maintenance of a magnetic tape file generally involves rewriting a whole reel of tape each time item changes are to be recorded.

In addition to this question of adequacy, there are some practical considerations to be dealt with. In the life insurance business, our practices are subject to review and supervision by the Insurance Departments of the various states. We have no way of knowing, for example, how long it would take for policy records in magnetic tape form to be acceptable to the state departments. Nor do we have any way of knowing how long it will be before the courts will consider acceptable, evidence existing in magnetic tape form. Microfilm evidence is still not acceptable in some courts. We think therefore that there still is some doubt as to the adequacy of tape records themselves—but even if this doubt is resolved, it will probably be a long time before the business community at large will consider tape records completely acceptable. For these reasons, we feel that insurance procedures intended for use in the next few years should not depend upon magnetic tape as a primary recordkeeping medium.

In developing the Consolidated Functions plan already referred to, a question arose as to whether we should suggest that the basic policy files be maintained in punched card form or in magnetic tape form. We chose to suggest punched card files—not only for the reasons already indicated—but also because of the relatively small increase in expected savings that could be attributed to the substitution of tape files for punched card files. We reasoned that the value of magnetic tape policy files over punched card policy files would be limited to not much more than the cost of transforming the card record to tape and vice versa, each time it was used. Under the consolidated plan such transformations are held to a minimum. To develop a measure of this, an estimate was made of the plan applied with a magnetic tape computing system and punched card policy files as compared with the same plan applied with a magnetic tape computing system and magnetic tape policy files. The estimated difference between these two ways of operating was small. The size of this difference among other considerations led to the opinion reported at the 1952 Eastern Spring Meeting of the Society of Actuaries to the effect that "at least so far as the life insurance industry is concerned, perhaps not more than 10 per cent of the entire potential possible with electronic devices can be attributed to an automatic file."

This analysis of punched card files versus magnetic tape files left the impression that tape files should not be counted on until extensive experience with tape as a processing tool—as a secondary record—has been acquired. With converters available to link existing punched card operations with tape processing systems, the need for introducing tape policy files does not appear to be a governing one. A very substantial amount of economy can be arranged through the use of tape computers—without the necessity of risking operation with tape files until more extensive demonstrations of their practicability have been made.

Limitations of Current Systems

In developing insurance procedures the choice of the methods to be applied is governed to a great extent by the capacity and limitations of the data processing system to be employed. The number of files to be kept, the manner in which they are to be maintained, the type of operations to be used and other such matters are practically prescribed by the necessity of avoiding the system's weaknesses while making extensive use of its strong points. For example, a sorting method which involves a minimum amount of writing on tape is to be preferred when the tape writing mechanisms are slow and less dependable than the internal components.

In developing the Consolidated Functions plan, it was necessary to take into account some of the limitations of the data systems contemplated. So far as the operation of the plan with current tape systems is concerned, the following devices were built in to overcome the more important of the system's limitations:

1. The available data systems do not include the facility of random access, except at prohibitively slow speeds. Accordingly, visual card files were retained to permit clerical references to be continued under the consolidated plan.
2. The available data systems do not lend themselves readily to the task of keeping a historical record of the account with policyholders. Accordingly, posted records produced by punched card tabulators were included in the plan.
3. Tape systems do not appear to handle sorting very economically, therefore, the procedures were designed with the idea of keeping the amount of sorting required to a minimum. One of the devices employed was the inclusion of a punched card policy file maintained in an order which would avoid sorting by the tape system. Such an arrangement, however, makes the file difficult to use for other purposes.
4. The available systems require regularized maintenance and testing to keep them in efficient operating order. Breakdowns, as with most machinery consisting of thousands of parts, involve difficult diagnostic work to analyze the difficulty and, sometimes, an extended repair job. Under the circumstances, it is questionable, at least, whether work which must be completed on an hourly or daily cycle can safely be entrusted to them. Thus, a monthly work cycle was built.
5. The available systems cost a great deal. For companies other than the very large one studied, a relatively small work load would be imposed by

the consolidated plan. This suggests the use of a service arrangement under which a computer might be rented for temporary periods. A number of checks and balances were built into the plan to permit safe operation with an outside service arrangement.

6. The available system transfers a great deal of control to a small number of persons associated with the operation of the equipment. Different approaches to internal auditing and checking may be indicated. More frequent checks on the accuracy of policy records are indicated. Periodic procedure reviews and test checks on performance and results achieved will also be necessary. In the Consolidated Functions plan, extensive consolidations are contemplated. However, three different departments, each with its separate records, are still retained. This is done primarily to include a basis for proper internal checks and balances.

This, of course, is by no means a complete list but it does serve to indicate some of the practical necessities to be kept constantly in mind. It is not solely an automatic processing problem that must be dealt with. It is a matter of devising a mechanization compatible with the current business climate and acceptable to the business community at large. Also, it must be one which can adequately be justified on economic grounds. Speed and availability of data are secondary considerations in the life insurance business.

Acquiring a System

A company which wishes to obtain first-hand operating experience with an electronic data processing system is faced with many questions. The most difficult to deal with is the matter of determining whether an electronic system should be acquired; and, if so, which one it should be. A prospective user of this equipment appears to have three choices. He may choose a system designed to operate from punched hole devices (punched cards or punched tape) thus limiting the speed and the degree of automation possible while keeping the price low. He may choose instead a system designed to operate from magnetic tape, thus reaping the advantages of greatly increased speed of operation. His other choice is to sit out the developments a little longer. This would be done with the expectation that future equipment will permit more automatic processes than now possible. Just which one of these should be followed depends on many practical situations within the individual companies. It also depends on whether the use of a system requires outright purchase, full-time rental, or an hourly service charge from a computing center. I believe you will be interested in the reasoning which led one company to contract for a magnetic tape system.

A Punched-Hole or Magnetic-Tape System?

This company operates with procedures that are mechanized to a fairly high degree and is current-engaged in several programs for converting additional clerical activities to a punched card basis. To settle on one of the three choices mentioned above, it was assumed that the Consolidated Functions approach supplied a rough measure of the degree of automation to be ultimately expected of data processing systems. Rough estimates were made of the cost of operating the plan after it had been completely installed and was operating on a company-wide basis. The estimates were made for operation with a punched card computer and punched card files, and for operation with a magnetic tape computer and punched card files. A comparison of costs favored the tape processing system but the difference was small. A choice could not be made on cost alone.

These studies made the consolidation idea appear very attractive, not only as a means of reducing operating costs but also as a means of streamlining the organization along workable lines. However, on the other side of the ledger, there were a number of deterring factors. Such a program would take a long time to install. The gains would appear only after a fairly extensive conversion had been made. The conversion would require producing punched card records for several million life insurance policies now recorded in typewritten card form. The loss of a very substantial investment in an existing recordkeeping system had to be taken into account. In addition, the capacity of the company to make the required changes was being taxed to a considerable extent by the several conversions to punched card systems currently being made. To these deterrents must be added the element of risk which exists in introducing equipment as yet untried on any commercial application. The company, therefore, although inclined to accept the idea that some sort of consolidated operation was indicated as a long-range objective, still felt that a system should be applied to a localized area as a means of getting started.

The company has a large area of actuarial work which is currently being done by an assembly of more than 100 separate punched card machines (involving a yearly rental of about $225,000). This work involves the development of the insurance statistics needed for the company's financial statement and for various experience analyses. This area of work is of such a nature that it permits the introduction of an electronic processing system with a minimum of disturbance and risk. It constitutes a severe test of the tape system because it involves a very large amount of sorting, an operation on which tape systems are admittedly expensive. It was found that a data system designed to operate from punched hole designations does not offer material gains over regular punched card equipment on this particular work. Studies and tests indicated, however, that a magnetic tape data processing system would offer substantial economy on this actuarial work. In addition, the magnetic tape system offers the added capacity needed to cope with certain non-repetitive types of special work such as is involved in determining new pre-

mium rates or in preparing new dividend schedules.

In this connection, it should be emphasized that the company involved had already consolidated its actuarial work for several different lines of business. Such an assembly of punched card equipment applied to producing insurance statistics would not be found in other companies.

Additional considerations favoring a magnetic tape system were found in the fact that such a system would be operated by a small number of people and would require fewer separate machines and less movement of work; also, in the expectation that fewer mechanical errors would occur with a system containing built-in checking devices.

Primarily, however, this company chose a magnetic tape system over a punched hole installation for one extremely important reason—the system could be gainfully introduced into this particular area without requiring a major reorganization elsewhere as a condition precedent. This provided the facility for a first-hand understanding of its capabilities and limitations through actual use, without risking the entire recordkeeping system of the company on its success. The fact that it could also be used in connection with a plan like the Consolidated Functions approach, the fact that it would be operated by a small staff and supplied desired reserve capacity of course weighed very favorably in the decision.

An Existing or Future System?

Having made this choice, it was still necessary to consider whether to acquire an existing tape system or wait for some future system which might be less costly or more versatile. An attempt was made to visualize in what respects a future system might surpass the existing ones. It did not seem unreasonable to expect that future systems would be more completely automatic. For instance, it was assumed that, instead of extracting information from files as a separate operation, devices for the automatic extraction and processing of information would probably be built in. It was likewise assumed that instead of getting answers first in tape form for separate printing on a different machine, a printing device tied into the system would be available. On the basis of this degree of automation an attempt was made to estimate, very crudely of course, how much more savings might occur if the Consolidated Functions plan were in operation; that is, the cost of operating this plan with an existing magnetic tape system was compared with an estimate prepared to reflect operation with the more completely automatic tape system assumed for the future. For lack of any better indication, it was assumed that an automatic tape system with built-in files and built-in printing mechanisms would sell for no more than an existing system without such built-in devices. This comparison suggested that perhaps 90 per cent plus of the total potential possible with such highly automatic future devices could be realized by the lesser degree of automation already possible with existing equipment.

Of course such a suggestion immediately leads one to wonder a bit. Perhaps a disproportionate amount of effort is being expended in a desire to make systems completely automatic. Maybe some of this effort should be directed toward pilot applications which will supply some field experience to work with. To us in the insurance field, the development of procedures to accommodate semi-automatic systems appears more certain than the development of more completely automatic data systems at a practical cost within the next few years.

The other consideration which entered into this question of "buy now or wait?" was an estimate of how long it would be before the company would be able to recapture the cost of a present system out of expected savings. After allowing for the necessity of starting out on a local operation, and the additional loss to operate on both the old and new basis at the outset, this period was estimated at somewhat less than four years. With such a rapid rate of buy back, coupled with the large proportion of the total realizable with existing systems, the question was resolved in favor of the introduction of an existing tape system.

This covers some of the attitudes developed by a group which is moving from the investigating phase into actual operation. Unfortunately, the only available basis for decision involves future projections and conjectures. With some life insurance companies acquiring tape computers within the next year, this projection basis may soon be displaced by actual experience. This will be valuable because visualizations have done about as much as they can. Actual use of current models on day-to-day work appears to be essential to the development of both the proper applications and the improved processing systems of the future.

Indications for the Future

It has been difficult for a potential user of a data processing system to decide what to do. He realizes that the greatest impetus to the development of improved systems will stem from day-to-day operating experience but he also is conscious of the possibility that any system acquired now may be out-of-date a few years from now. His plight is not much relieved by the many projections being made in engineering circles—promising very complete automation; promising transistorized computing systems; promising inexpensive small units; and so on.

Those of us who must deal with this matter need some good indications as to what and when you engineers believe you can deliver. Let a picture of a transistorized computer appear in one of the popular magazines and we immediately have to deal with the question of whether or not the present vacuum-tube computers are obsolete. Let some ideas as to photographic storage appear on the horizon—and we begin to wonder