COMPUTERS
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Outlook for Computer Control in the Process Industries

Present Vacancies in the Computer Field

Bibliography on High School Mathematics Education

MAY
1959
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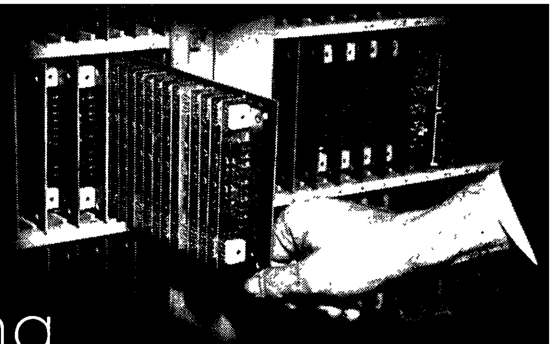
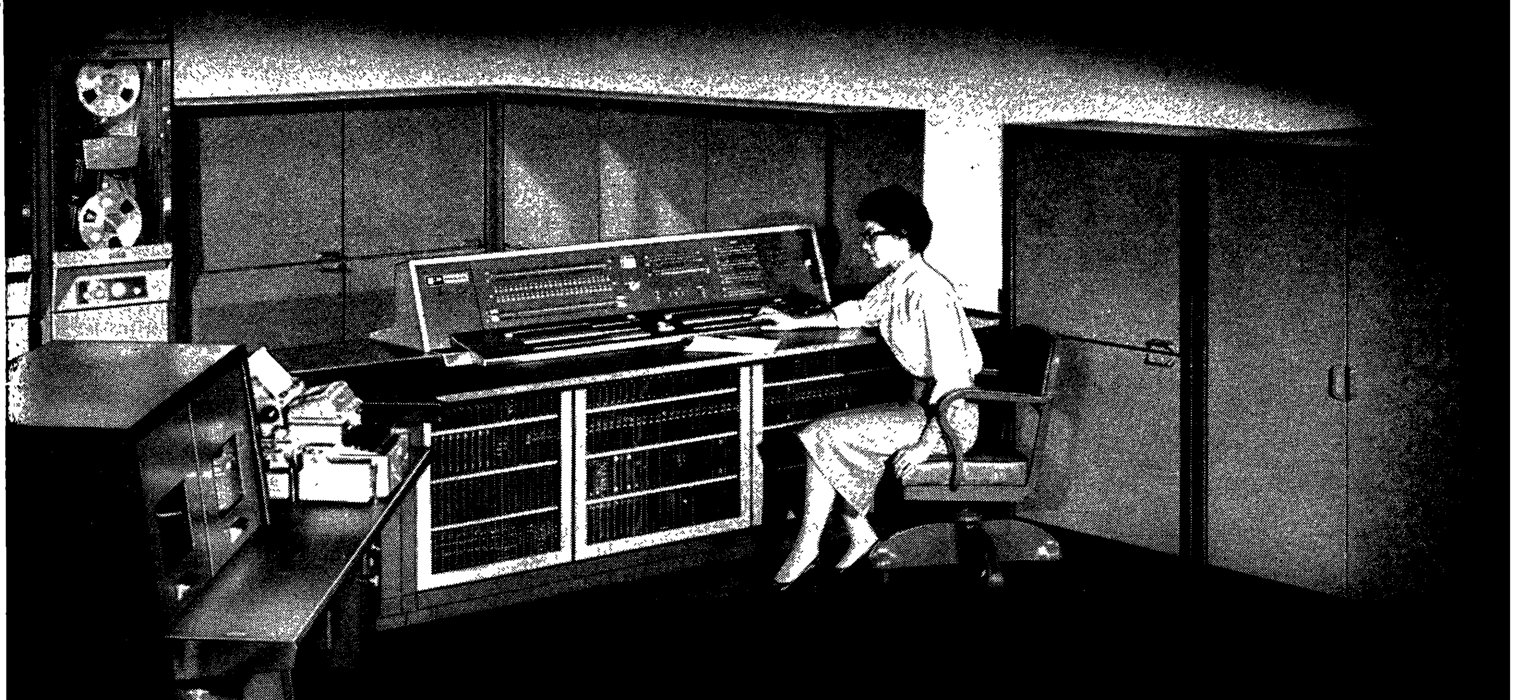
VOL. 8 - NO. 5

The Ultimate in Advanced Data Processing





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Volume 8
Number 5

MAY, 1959

Established
September 1951

COMPUTERS and AUTOMATION is published monthly at 815 Washington St., Newtonville 60, Mass., by Berkeley Enterprises, Inc. Printed in U.S.A.

SUBSCRIPTION RATES: (United States) $5.50 for 1 year, $10.50 for 2 years; (Canada) $6.00 for 1 year, $11.50 for 2 years; (Foreign) $6.50 for 1 year, $12.50 for 2 years.

Address all Editorial and Subscription Mail to Berkeley Enterprises, Inc., 815 Washington St., Newtonville 60, Mass.

ENTERED AS SECOND CLASS MATTER at the Post Office at Boston, Mass.

POSTMASTER: Please send all Forms 3579 to Berkeley Enterprises, Inc., 815 Washington St., Newtonville 60, Mass.

CHANGE OF ADDRESS: If your address changes, please send us both your new address and your old address (as it appears on the magazine address imprint), and allow three weeks for the change to be made.

Readers' and Editor's Forum

FRONT COVER: GIANT COMPUTER IN TRAILER INTO SHIP'S HOLD

The front cover shows a giant computer, an IBM 704, contained in a truck trailer, being lowered into the hold of the passenger ship "President Polk" at a San Francisco dock, on its way to Japan. The 15-ton data processing system was on a 10,000 mile journey from International Business Machines Corp., Poughkeepsie, N.Y., to the Japanese Meteorological Agency, Tokyo, Japan. There it is being put to use to make more accurate weather predictions, using methods similar to those applied in the Joint Numerical Weather Prediction Unit in Washington, D.C. It is tracking and predicting typhoons and other storms, and contributing to international weather forecasting. The shipment was placed uncrated in a household goods van of the Neptune World-Wide Moving Co., in Poughkeepsie, N.Y., and was not taken out again until its arrival in Tokyo, Japan.

THE SOCIAL RESPONSIBILITIES OF COMPUTER PEOPLE — ACM COMMITTEE NEWS

The first report of the Association for Computing Machinery Committee on the Social Responsibilities of Computer People was released on January 7, 1959, and printed in the February issue of **Computers and Automation** (p. 6).

At the meeting of the Council of the ACM in San Francisco, on March 4, the report of the committee was formally presented to the Council and accepted by the Council. It has now been submitted to the editor-in-chief of the **Communications of the ACM** to be considered for publication upon his discretion. A motion to discharge the committee was defeated. Instead, the Council accepted the recommendation that the committee be continued on a stand-by basis.

With these actions the Council clearly established a procedure whereby the ACM may officially take cognizance of serious issues in the important area of professional, ethical, and social questions arising among its members.

A member of the Council, Prof. M. S. Wilkes of Cambridge, England, pointed out several months ago in a letter to the Council of the ACM, that authorities in some foreign countries might, because of the inclusion of material on the social responsibilities of computer people in publications of the Association for Computing Machinery, change their official attitude towards the publications of the ACM, as for example in postal classification. But this possibility seems remote and farfetched in a time like the present, when more and more freedom to know and to discuss is returning all over the world.

Plans are being considered for a session on the social responsibilities of computer people at the annual meeting of the ACM, September 1 to 3, at Mass. Inst. of Technology, Cambridge, Mass.

AUTOMATIC COMPUTING MACHINERY — LIST OF TYPES — SUPPLEMENT

I. From Peter D. Tilton

Stanford Research Institute
Southern California Laboratories, South Pasadena, Calif.

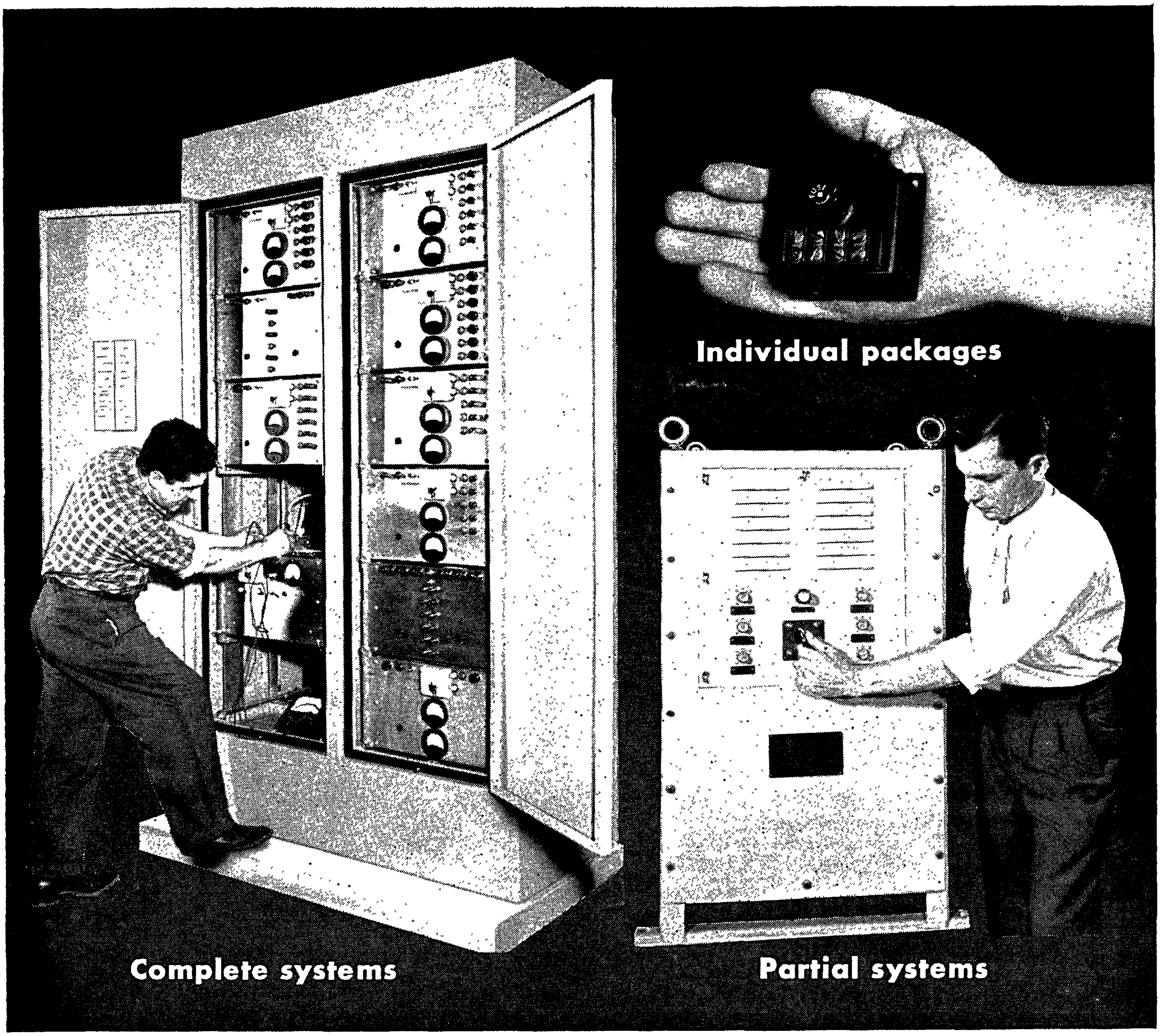
To the Editor:

With reference to the list of types of automatic computing machinery which you publish (Volume 7, No. 11, November 1958, p. 20), a few suggestions may be in order regarding machine tool computing equipment. In particular, the four items in this category in the November 1958 listing appear to have come from different sources and therefore are somewhat overlapping in their definitions.

A more appropriate listing would recognize the following separate and distinct general types of machine tool computing machinery:

1. Machine tool control equipment, which operates automatically from the programmed instructions to control the operation of the machine in shaping a piece of material.
2. Machine tool control media-producing equipment, which automatically prepares the machine instructions and/or control data in the proper form on some acceptable storage medium (e.g. punched tape, punched cards, magnetic tape). Such equipment may be of three types:
   a. Manual input, as in the case of special keyboard or automatic typewriter devices.
   b. Aided manual, or semi-automatic input, which is distinguished from the manual (digital) input type because of the analog fashion in which some of the data are provided or used. (This category thus would include record/playback devices, model-tracing equipment, tape template systems, and the like.)
   c. Media input, which can accept a standard form of storage media such as punched tape, punched cards, or magnetic tape produced by a general-purpose digital computer.
3. Machine tool control media-verification equipment, which in addition to discriminating the adequacy of the stored signals also checks the data content against the machine characteristics to insure that proper operation will result (e.g., that programmed accelerations and decelerations are acceptable, that allowable feed rates are not exceeded, that motion beyond limit stops is not specified, etc.).

[Please turn to page 30]



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The Outlook for Computer Control in the Process Industries

I. Melville Stein, President

Leeds and Northrup Company
Philadelphia, Pa.

(Based on a talk given at the Symposium on Instrumentation for the Process Industries, Agricultural and Mechanical College of Texas, College Station, Texas, January 21, 1959)

I would like to say first that I am an optimist about the future of computer control. I tell you this now so that you will not misunderstand some words of caution that I wish to give at the outset of my remarks. I think one can have sound and conservative optimism without giving way to unsound and unbridled overenthusiasm.

Some producers of computers who have only recently attempted to enter the field of automatic control of continuous processes are, in my judgment, promising too much too soon. Among these newcomers to the automatic process control field are companies whose competence in the field of computer techniques is excellent, but there is much more to the automatic control of continuous processes than sound computer techniques.

I am much concerned about the setback computer control may experience if, as the result of promising too much too soon, there are many disappointments in actual performance. This situation has already developed in the application of computers to office procedures. Notwithstanding the tremendous success of computers in certain technical, statistical, and military applications, there have been too many unsuccessful office applications. In these cases, after the expenditure of much time and money in preparatory work and the purchase of expensive equipment, the promised savings, or other benefits, have not materialized. . . . .

Premature Claims Hurt Electronic Amplifiers

Only a few of you, perhaps, are old enough to remember the setback experienced in the application of electronics, particularly vacuum tubes, after these devices first became generally available in shops catering to the users of radio receiving sets. Because of the amplifying feature of vacuum tubes many users and some suppliers of measuring instruments and control devices rushed in to take advantage of what they mistakenly believed to be a new order of sensitivity in measuring and control circuits. The result was not good. As a consequence, when vacuum tubes and their related circuits had been developed to a satisfactory degree of reliability, many purchasers who could have benefited by the use of electronic devices shied away from their use, because of the bad reputation that premature claims and promises had given them. Actually, many years before electronic devices were generally available, galvanometers with optical or thermal amplification had been used down to the natural limit of sensitivity, as fixed by the Brownian motion in the suspended system, and this with a response time of about 0.01 second. It was many years later before electronic devices could be used down to the equivalent natural limit of sensitivity, as fixed by the so-called Johnson noise.

Of course, what made the electronic approach so attractive was the first impression that relatively high sensitivity could be achieved with compact and inexpensive apparatus, but stability and reliability were lacking. As a result of the contributions of many workers in this field, electronic detectors and amplifiers were eventually stabilized and otherwise made reliable. By the time the necessary features were added to provide this stability and reliability the electronic devices were not so compact or inexpensive. Nevertheless they had numerous other advantages, so that their use has not only become wide-spread but both their size and cost have been reduced remarkably.

Precise Amplifiers Developed Slowly

Stabilized, direct-current amplifiers, having appropriate characteristics, have come into extensive use in many types of computers, as a result of a long development process. . . . Highly stabilized amplifiers having characteristics suitable for use in computers are now available and are being widely used particularly in computers of the analog type. Many of you in the process industries will recognize these as the so-called "operational amplifiers." Such computers are being used for analysis, for automatic control and for other purposes.

The significant point here is that from the time that vacuum tubes first became generally available it has taken nearly four decades to develop electronic detectors and amplifiers having the stability, reliability, and flexibility needed in the field of refined measurement and automatic control. From the time the first direct-current, stable-zero, electronic instrument became available for this class of work it has taken nearly three decades. And there is still room for improvement. I think we can assume that progress will be more rapid in the future, so that I do not expect full fruition of digital computer controls to take that long, but I feel practically certain that it will take more than a year or two. It is precisely because I am optimistic about the future of these computer controls that I do not wish to see the time to come to full fruition unnecessarily lengthened by setbacks that could easily occur as the result of promising too much too soon.

Significant Advances in Refined Automatic Control

Probably you would like me to proceed at once to give you my views about the future of computer control. I must, however, ask you to be patient a little bit longer while I review briefly a few of the most significant steps in the development of refined automatic controls. I feel that it is necessary to keep in mind some of these significant steps in order to see the role of computer controls in proper perspective.

I hope that you will forgive me if I use some old-fashioned general terminology, instead of the more precise and specific terminology that has been adopted by the experts in recent years. I am all in favor of this new terminology for detailed technical discussions and actually have helped to establish it, but in certain cases the more general terminology seems more appropriate for my present purpose.

Speed Governors

I expect you all know that the earliest automatic regulating controls that came into general use were speed governors, used first on steam engines and then on steam turbines. Later, there were the simpler forms of damper controls for furnaces. To avoid oscillation or "hunting," all of these controls were stabilized by giving them what we used to call a "drooping characteristic." That is to say, in the case of speed control, as the load was increased on the engine or turbine, the governor maintained a progressively reduced speed. To reduce this change of speed with load, there were developed the so-called "isochronous" governors. The word means constant time, and the name indicates that they held constant speed — but they did not. With ample power available to drive them, and through excellent design, these isochronous governors were much more sensitive than their predecessors, and, therefore, in going from light load to full load the range of speed was much reduced. But the drooping characteristic was still there to give stability. They served very well in their day, but would be quite inadequate for modern, large scale, electric power systems, in which the required constancy of frequency is controlled by very sensitive electrical devices responsive to the generated frequency.

It was not until World War I days that controls were devised which, while retaining the stability of the earlier controls, as provided by the drooping characteristic, effectively eliminated the drooping characteristic and thus brought about automatic control at a fixed value, regardless of load changes or other variables.

Leeds' Contribution

The manner in which this development occurred may be of interest. Along about 1910, Morris E. Leeds had succeeded in devising robust, machine-like, recording instruments for temperature measurements in industrial plants. These recorders were of the "null" or balance type, utilizing potentiometer and Wheatstone Bridge circuits. Incidentally, I believe that this was the beginning of "moving the laboratory out into the plant," which expression we frequently hear today in connection with the introduction of a new process instrument. The use of these sensitive, wide-chart recorders in industrial processes brought to light theretofore neglected process phenomena now frequently referred to as process lags. Leeds analyzed these effects critically and was very quick to realize that they presented important limitations to refined control of industrial processes. His pioneer contribution to automatic control quickly followed.

Following the introduction to industry of the first Leeds Potentiometer Recorder in 1912, it very quickly became apparent that these machine-like industrial measuring instruments could be equipped with certain auxiliary devices to provide automatic control of industrial processes. To suggestions from within and without his own organization that these instruments be equipped with simple "on-and-off" electrical contacts to provide automatic control, Leeds was very cool. He already had given considerable thought to automatic control because his industrial recording instruments involved in themselves some rather refined automatic control problems. He was satisfied that simple "on-and-off" control could not be expected to give good results in more than a few rather elementary applications. For the more difficult industrial control applications, he visualized the mental processes and the alert manipulations of an intelligent operator watching an array of measuring instruments and trying to make the adjustments necessary to maintain the desired conditions. He was convinced that unless an automatic control device took into account all of the factors, the weightings, and the timings that a good operator did, it would not be successful; but he also was convinced that an automatic control device that did take into account all of these things could do a better job than the best operator could do. His visualization of sound automatic control was reduced to mathematical formulas and to experimental apparatus design at the time he applied for his pioneer automatic control patent (no.-1,332,182) in 1917. These principles form the basis of all refined automatic control today. In the more than 40 years since Leeds applied for his patent, further improvements have been made in automatic controls, but it is interesting to note that these improvements have come from adding factors and functions rather than by omitting any that Leeds considered essential.

The "Feedback" Principle

The initial action in the Leeds control followed the earlier practice of providing stability by the use of the "drooping characteristic," but the initial action created almost simultaneously in the control circuit an auxiliary electromotive force which was "fed-back" into the control circuit to return the temperature to a fixed value regardless of load and other conditions. This auxiliary electromotive force was applied in such a way as to return the temperature to a fixed or normal value just as quickly as the ever present process lags would permit. This was accomplished by making the "feed-back" responsive not only to the magnitude of the departure from normal but also to the rate-of-return to normal. Thus, in controlling temperature, and assuming the temperature to be below normal for some reason, heat would be applied to prevent further reduction in temperature but, in addition to this action, the control would start to add more heat so as to bring the temperature fully back to normal at the maximum rate that could be tolerated without causing overshooting or oscillation. Here again I should like to emphasize that this maximum rate was fixed primarily by the process lags. The term "feed-back" control is frequently heard today and the experts define several forms of feed-back, but the basic use of feed-back control had its origin in this contribution by Leeds many years before the term "feed-back" was coined.

Lags and Limitations in the Process

In early applications of comprehensive and coordinated systems of automatic control to large boiler furnaces, and in other similar control applications, the refinements in the controls could not be made fully effective because of the lags and other limitations in the process itself. This should not be at all surprising because in most cases the process layout and the process equipment were designed with practically no attention to the requirements of refined automatic control. Today, in designing a new process plant, the control requirements are considered from the very outset and this, of course, is essential if optimum control is to be achieved.

This is the first of two points that I wish to emphasize in reviewing the advances in refined automatic controls, namely, that the full advantage of advanced forms of control cannot be realized unless the process plant itself is susceptible to such control. I emphasize this point here because I wish to refer to it again in discussing computer control.

First Electronic Recorders

The feed-back controls to which I have referred were for many years provided in most instances as an adjunct to a recorder. Even though the chart might be omitted, so that the instrument was only an indicator, the control operated through what was essentially a recorder mechanism. This arrangement introduced into the control function certain errors and certain time-lag in the recorder mechanism. The very high speed and sensitive electronic recorders devised by Williams,* as I have already mentioned, greatly reduced the instrument lag and error; but, when first placed on the market, these electronic recorders were rather large and expensive and these factors placed a limit on their use where large numbers of controls were involved. Since that time both the size and cost of these instruments have been very much reduced.

Direct or "Blind" Controllers

In the meantime, as the advantages of refined automatic control became more fully recognized and as the process plants were improved to be more susceptible to refined control, the error and time-lag in the recorder mechanism became limiting factors which it was desirable to eliminate. This led to the development of direct or "blind" controllers which performed their control function directly — that is, without going through a recorder mechanism. Williams* described high speed electronic feed-back controls of this type for positioning valves and similar regulating devices and also for speed control of electric motors. The recorder when added to such systems became the adjunct to provide valuable assistance in attuning the control to the process and in spotting and analyzing quickly any disturbances that might occur either in the control system or in the process itself.

Direct Control from Computers

Such control systems are still undergoing development and improvement to make them better for today's needs and to adapt them to the needs of the future. In this connection, about two or three years ago, some technologists active in the field of process controls expressed the view that it was not worthwhile to further improve such direct control systems because they would soon be made obsolete by the use of direct control from computers. I may say at once that I was not one of those who took this view seriously. It seemed inconceivable to me that in large scale continuous processes a single complex unit would be entrusted with the basic control, so that if anything went wrong with the one complex unit all control would be lost. I am glad to be able to say that most of our staff of technologists specializing in process controls were in agreement with my own views.

We had the good fortune a little later to have a conference with a representative group of control technologists from Great Britain. As many of you know, the British have been very progressive in the field of automatic control theory even though, at times, they have allowed other countries to be the first to apply these theories. It was very comforting to learn that these distinguished British technologists were unanimous in their view that direct or "blind" controller systems would not be made obsolete by direct control from computers. This same position is supported by the consideration that much of the first cost and the maintenance cost of such control systems would be necessary anyway even though the attempt were made to substitute computer control. From a number of recent articles in the technical press, I get the impression that the idea of replacing direct or "blind" control by computer control has largely disappeared.

This is the second of the two points that I want to emphasize in reviewing automatic control advances. In other words, individual, process-variable controllers are here to stay and computer controls will be in the nature of an additive refinement, so that if the computer should fail to function properly only the additional refinement which it contributes would be lost and the conventional control system would continue to provide stable operation just as it did before adding the computer refinement.

The Future of Computer Control

I hope that the foregoing brief review of advances in the art of refined automatic control has made it clear that computer control offers not a substitute for present conventional control, but a refinement achieved by addition to such control; and that the full realization of this additional refinement will depend upon the extent to which the process itself is susceptible to this additional refinement.

As an intermediate step toward computer control, a satisfactory computer can be of great value in analyzing the static and dynamic characteristics of the process to determine where the process operation may be improved from a control point of view and to appraise the prospects of the advantages to be gained by adding computer control. A logging system provides a periodic read-out, in digital form, of all the process variables and provides an auxiliary read-out, also in digital form, of abnormal performance at any of the control points or of any other process variables. This latter feature permits the plant operator to adjust the individual control points to give the optimum performance attainable in the process as it exists. Additionally, the computer may be used to calculate involved relationships and to print out "operating guide" information.

* Trans. A I E E, Vol. 57, 1938

Programming of the Computer

As you are undoubtedly aware, both the intermediate and the ultimate use of computers to improve the control of continuous industrial processes require what is called the "programming" of the computer. This requires determining the static and dynamic characteristics of the process and then adjusting the programming element of the computer to take these characteristics into account.

It should be obvious that for the programming adjustments to be correct for a reasonable length of time the characteristics of the process itself must be stable over that interval, regardless of such factors as changing ambient temperatures and cleanliness of the system. It is possible by using what some control technologists have called "adaptive control" to have the computer automatically readjust its own programming to take into account changes in one, or a few, of the process characteristics; but if many of the characteristics required such treatment the use of adaptive control could readily become impracticable for one reason or another.

Reliability of the Process-Control Computer

It goes almost without saying that the successful application of full computer control requires a very high degree of reliability in the computer. It was because of the non-availability of computers that appeared to be entirely satisfactory for this purpose that Leeds & Northrup Company, about a year ago, entered into a cooperative agreement with Philco to develop a computer of adequate reliability and having other suitable characteristics. An unusual degree of reliability had already been demonstrated by the basic Philco computer in important military applications. The purpose of the cooperative development is to adapt the basic arrangement to automatic control of continuous processes without diminution of the basic reliability. The development work in the Philco Laboratories, and in the L&N R&D Department has made steady progress and the outlook for achieving the desired result is quite encouraging.

Study of Process Dynamics

Regarding continuous industrial processes themselves, the technologists of the operating companies have made, and are making, extensive studies of process dynamics, but much remains to be done in this field before the prospects for full computer control can be properly appraised. I have already referred to advanced British work in the field of control theory. They are also engaged in advanced studies of process dynamics. Recently I was informed that in England it is a definite requirement that most candidates for a degree in Chemical Engineering must have completed an adequate course in process dynamics.

The Ultimate Limit to Computer Control

It is interesting to speculate as to what will place the ultimate limit on computer control of continuous industrial processes. Will it be the limitations of computer controls, or will it be the limitations of the process itself? Some of the leading technologists in the process industries feel that the limiting factor will be the computer controls rather than the process characteristics. As an optimist engaged in the development and production of computer controls, I feel that the ultimate limit will not be in the controls. Based on past experience in the development of refined controls, as I have just very sketchily reviewed, I expect a sort of "see-saw" pattern in which both the controls and the process plant are continually improved with the limitation shifting from time to time from one to the other. At any one time, of course, the capability of the controls might be in advance of the capability of a particular process or plant to respond to the full capability of the controls, while in another particular process or plant the reverse might be true. Probably the ultimate limit will be an economic one, wherein refinements in both the controls and the processes will have reached the point of diminishing return so that further refinements in either would not be economically justifiable. In any event, I feel we are a long way from ultimate accomplishment in either category.

In parallel with its developments in the relatively new field of computer control of continuous processes, Leeds & Northrup Company is carrying on several major developments which constitute improvements and extensions of process control systems, which it has been producing for many years. Computer control has already entered these developments in a major way, but the full extent to which it will be found justifiable is not yet clear. Neither is it clear whether the computers to be used in the ultimate developments will be of the digital or analog type. Probably there will be need for both.

Uses of Analog Computers

For installations where they are applicable, analog computers, presently at least, are likely to be simpler, more reliable and less expensive than digital computers. Also, analog computers are very useful and are rather widely used in "ratio" and "cascade" control systems.

Electronic analog computers, utilizing direct current signals for both the input and output circuits, provide great flexibility and permit combining the computer signals for various computing operations. This same flexibility makes these computers especially adaptable for use in end product control from suitable analyzing instrumentation. This is an active and growing field.

Coordinated Control Systems

As an outstanding example of control through the use of combined or coordinated control systems, I may cite the comprehensive and complex continuous processes involved in the electric utility industry. Here the automatic control problems fall into three general categories: the heat generation, the electrical energy generation, and the transmission of the electrical energy to the points of ultimate use. Although the control systems for each of these categories have been developed as more or less separate entities, they are already being tied together to some extent into one comprehensive system and in the ultimate development all three categories are expected to be fully coordinated. Needless to say, this must be done to the fullest extent possible in ways that will isolate any failure to its own area and will not cause disturbances in other areas of control. Figuratively speaking, this involves a comprehensive system of automatic control "from the coal pile to the lamp socket on the customer's premises." This is figurative language because many utility companies use oil or gas, instead of coal, or some combination of them, and in the not too distant future new plants will be tending increasingly to heat generation from nuclear fuels rather than from fossil fuels. The controls for nuclear fuel plants are necessarily of a much different character from those for fossil fuel plants. For many years to come, however, most of the new capacity installed will involve the use of fossil fuels and many of these now in process and to be built in the future will utilize boilers of the "once through" type, an increasing number of which will operate at critical or supercritical pressures. The development of adequate controls for such high pressure boiler plants is fully as fascinating and challenging as the development of controls for nuclear power plants.

Dividing up a Complex Process

One reason for telling you something of our development programs pertaining to large, comprehensive, continuous systems is that I believe the general approach I have outlined is a sound one to follow in striving for real success in the development of full computer control of large, complex and continuous industrial processes. In other words, where possible — and it may not always be possible — it is better to segregate the whole complex process into several discrete major parts and to do a very thorough job of controlling each of these parts, instead of attempting as the first step to control the whole comprehensive system. When really satisfactory control of each such discrete major part has been achieved, it should not be difficult to coordinate the several parts to provide sound over-all control, particularly if this ultimate goal is kept in mind from the outset. I believe that this procedure will not only shorten the time to achieve ultimate success but will produce more reliable over-all control of a comprehensive system.

In One Installation Actual Saving from Computer Control Exceeded Estimated by 100%

Computer control is already in use in the generation and transmission categories of electric utility system operation. An L&N computer of the analog type was installed on the Southern Company's network, approximately five years ago, and this was designed to accommodate full computer control at a later date. Full computer control of this network, which supplies many of your near-neighboring states, is in the process of installation. This control was installed to determine the generation at various sources for optimum transmission efficiency and was estimated to save the full cost of the installation in one year. I am happy to be able to say that the actual savings, from loading units in accordance with computer directions, have exceeded the estimated savings by about 100 per cent. Additional savings are expected when full automatic operation is completed.

A Dial-Programmed Computer-Control

Another analog computer-control, known as a "Desired Generation Computer" was installed on the Southern California Edison system in September 1958. In this arrangement the programming is done by the operator setting a number of dials to "instruct" the computer and from then on the control is fully automatic. Computer-controls of this type are presently being built for several other interconnected power systems.

In this field of digital computers applied to industrial process control, a little under a year ago, Leeds & Northrup Company made its initial installation in your neighboring State of Louisiana — specifically, at the Esso Refinery in Baton Rouge. After preliminary adjustments had been completed, this unit went into 24-hour line operation on July 1, 1958. Although adaptable to full automatic control this computer is used as a guide to the operators and for system studies which are essential prior to attempting full control. The 24-hour line operation continued for twenty-four days before a computer component failed. There have been additional failures of this same type. These failures were promptly corrected by replacing the defective components and were not serious in the present service of the computer. As I have indicated earlier, however, for full computer control more reliable computers are needed.

This completes my presentation on the future of computer control, but before concluding I wish to refer very briefly to two corollary matters that I think are quite important.

Cooperation Between Control Manufacturers and User Organizations

I think there has never been an undertaking that requires more cooperation between the user organizations and the control manufacturers than the application of computer control to continuous industrial processes. Fortunately for all concerned, and particularly for the control manufacturers, many of the best brains in this field are associated with progressive user organizations. Without their full cooperation the control manufacturers would find it extremely difficult, if not impossible, to carry out the studies and developments essential to real success. It is largely because of the splendid co-operation that exists between the personnel of progressive user organizations and the personnel of the leading control manufacturers that I am optimistic about the future of computer control.

Careers in Process Control

I believe that most of you are associated with industry in the field of instrumentation and process control, either with organizations which are users of process control equipment or with manufacturers of such equipment. A few of you I believe are still university students, either undergraduate or graduate students. A few others are faculty members and possibly some of you who are in industry are considering teaching careers.

Perhaps what I have said may indicate to all of you — if you did not already know it — that the whole field of automatic process control, including modern comprehensive control systems, with or without full computer control, is a very fascinating and challenging one. I am certain that the problems involved are sufficient to tax the best brains among technologists who have the basic training for such work.

Industry has need for outstanding technologists thoroughly trained in the field of instrumentation and control; and in view of the bright future of this field, as I have attempted to outline it, this need will be an increasing one. Courses like this one are of great help in enhancing the competence of those specializing in process control; and the sponsors are to be commended for initiating and conducting such courses. However to meet the requirements of the future something more is needed.

Education of the Control Technologist

Recognizing the current and future need for more technologists thoroughly trained in the field of instrumentation and control, the Instrument Society of America, in 1951, conceived the idea of a Foundation to further such training. After several years of study, a Commission of industrialists and educators was appointed to plan such a Foundation. In 1956, the Instrument Society accepted the report of the Commission and voted a substantial initial grant to start the Foundation. Its name is the Foundation for Instrumentation Education and Research (F I E R). I am pleased to say that I have the privilege of serving as one of its Trustees. I know that many of you are familiar with all of this and, perhaps also, with the fact that the Foundation's program is really under way. Among other activities, it is the aim of the Foundation to sponsor and support fellowships in its field at the graduate level. The conditions of these awards have been established with the hope that they will enable the cooperating universities to strengthen the faculties and the curricula devoted to advanced study in instrumentation and control..

I have mentioned the importance which the British attach to thorough training in process dynamics. Some of our universities, I understand, are offering such courses, but I am not sufficiently well informed to know just how extensive and intensive such courses are, or to know what is planned for the future. I do want to emphasize the need for graduate courses in process dynamics and to express the hope that with proper support from industry the universities will provide adequately for such advanced study.

Whether in the university or in industry, I believe, that in this fascinating and rapidly advancing field of instrumentation and control, there will be found very satisfying and rewarding careers for technologists who are interested and competent. If anything I have said should influence any of you to take up teaching careers at the university level, and in the field of instrumentation and process control, I should be very pleased.

PARI-MUTUEL MACHINES FOR SCHEDULING SERVICE CALLS

An electrical totalisator system, similar to the pari-mutuel machines that compute the odds at race tracks, has been adapted to industrial use. The Baltimore Gas and Electric Company has found the machine, called an "Indus-Tote" useful in dispatching and scheduling the gas service calls.

The "Indus-Tote," a product of the American Totalisator Division of Universal Controls, Inc., has been able to reduce operating costs, by balancing available man-power with workload, reducing overtime, and enabling the service dispatcher to handle day by day swings in the service workload. The machine maintains a running account of the service calls received, the promised date of completion, and the number of man-hours required to complete the job.

The Indus-Tote uses three rows of keys. The top row is used to record the day on which the customer's request for service must be completed. The bottom rows transmit the classification of the work, which is transformed into man-hours of work within the machine. The visual integrators of the "Indus-Tote" show the total man-hours of work permitted at any time in each classification, and also show the accumulated total work load promised for completion for any time in three consecutive days.

ON ECONOMICAL DEBUGGING

C. R. Blair
Department of Defense
Washington 25, D.C.

About one-third of the time of many high-speed, digital computers is used to eliminate errors from new programs. "De-bugging" is a necessary consequence of the fallibility of people and the literalness of computers.[1] For the machine can only do precisely what it has been instructed to do, while its human programmer — who was designed more for flexibility than precision — discovers that "bugs" creep into his coding despite his best efforts to exclude them. Digital computer time is still expensive. And even the most conscientious programmers waste many valuable minutes by letting the machine sit idle while they decide where to look next.

Many computer installations have adopted drastic measures to reduce the cost of "de-bugging." For instance, some programmers never touch the machine that performs their problems. A new program is turned over to an intermediary, who runs it to a stop or failure and returns the contents of storage at that point to the programmer. From these bare bones, the programmer is expected to discover the cause of death. Admittedly, such a procedure saves computer time; also admittedly, it requires more programmer time and prolongs the gestation period of the problem.

Now no one is really concerned about the poor programmer, for after all, programmer time can be bought for a fraction of the cost of computer time. But a problem frequently comes along that must be done in a hurry; then efficient procedures are forgotten while the programmer sits at the console and stares at the lights. For nothing can locate program faults as quickly as a computer, and nothing encourages "de-bugging" as much as having the appropriate buttons at one's fingertips.

What will it cost to combine the best features of both systems? Surprisingly little. A duplicate set of input-output equipment, some extra, low-speed storage, and a console that can disconnect from the processing unit[2] will give the advantages of console "de-bugging" at little more than external "de-bugging" prices. For these items can be bought for pennies per minute, but their purchase will permit fuller use of the dollars per minute computer.

The machine is working on an operational problem when a programmer arrives with an "unsanitized" program. He loads his tape (or cards) into auxiliary storage. Then, when ready to run, he presses the start button. Before he has withdrawn his finger,[3] the computer has stopped the operational program, exchanged the contents of main storage and the registers with the contents of auxiliary storage and begun to execute the new program. As soon as the new program stops or fails, it is shunted to the auxiliary store; the operational program is recalled, re-started where it was interrupted (for a computer is not affected by the time or happenings between successive instructions if everything in storage is restored)[4] and continues until the programmer again pushes the button to continue "de-bugging."

The "see-saw" action shifts the function of the main processing unit from one job to another — to the programmer when he can really use its capability in "de-bugging," to operations when he cannot. Thus, the programmer has the convenience of using the computer to locate faults, and operations has the use of the machine during those long, frequent intervals while the programmer decides what to do next.

[1] While auto-coding techniques can reduce the amount of "de-bugging," they cannot eliminate it.

[2] In many existing machines, separation of the registers from their indicators would be prohibitively expensive; but modern, transistorized computers usually require separate indicator "drivers" which can easily be adapted to perform this function.

[3] About one-thirtieth of a second if a drum is used for auxiliary storage.

[4] Except, of course, for "real-time" programs.

RELIABILITY ENGINEERING:

A NEW APPLICATION FOR COMPUTERS

Reliability engineers have a new application for computers. David Ehrenpreise, a reliability consultant to Sperry Gyroscope Company, in a talk to Long Island radio engineers, stated that the key to new advances in reliability analysis lies in electronic computer applications of mathematical analysis to reliability problems.

Advanced methods of reliability engineering now place greater emphasis on:

(1) measuring the severity of the environment, and reporting it as an "input signal" operating on all missile and space-borne equipment;

(2) analyzing the weight and strength of equipment as "mechanical overhead" factors that can penalize performance; and

(3) using an electronic computer to maximize reliability by mathematical analysis.

Systems of dozens of equations containing physical variables such as performance, weight, maintainability, measure of severe environment, cost, may be used to predict reliability. Prior to the computer these equations took teams of calculating specialists more than a year to solve. The same equations now yield a solution in a few days as a result of electronic computers.

Mr. Ehrenpreise stated that the coming of the space age had increased environmental severity thirty times in the last five years.

PRESENT VACANCIES in the COMPUTER FIELD

Patrick J. McGovern
Mass. Institute of Technology
Cambridge 39, Mass.

What professional opportunities are immediately available for the experienced computer designer and engineer? A survey of employment advertisements in recent issues of magazines in the computer field reveals interesting facts about the types of companies having the greatest present need for computer people, and the classes of positions they have open.

Forty-four advertisements seeking to attract computer personnel were analyzed from March issues. These were classified into four groups according to the nature of the firm advertising. Each of these groups was then analyzed to find the range of positions each was offering the experienced computer person.

Companies Seeking Computer People

The four classifications for the companies advertising were:

Group A: Companies dealing with the application of computing machinery to the aircraft and missile industry, and related fields such as air traffic control, guidance systems, etc.

Group B: Companies dealing with commercial applications of computing machinery, such as accounting, data processing, marketing analysis, operations research, etc.

Group C: Companies dealing with the application of computing machinery to defense systems such as radar, missile detection, tactical information handling, etc.

Group D: Companies dealing with the experimental development of computing machinery and its components, with a strong tendency to use the pure researcher in the physical sciences in improving memories, transfer points, masers, etc.

Leading the groups in total number of companies advertising was Group A with thirty percent of the advertisements. Group B placed second with twenty-five percent of the advertisements. Groups C and D were tied for third place with twenty-two and a half percent each.

Types of Available Positions

In the types of positions offered by each of the groups, the experience of the desired professional computer man and his job title were usually complementary. Both the job type and the experience levels desired by each group are listed as follows:

Group A: These companies are presently interested in computer people experienced in:

Digital system design
Reliability analysis
Digital motors
Airborne digital computers
Correlative controllers
Recording memories
Servo-mechanisms by computer control
Support for airborne computers
Space vehicle computer control

The experience levels desired by these firms ranged from three to seven years of industrial experience, and at least a B.S. degree in engineering or its equivalent.

Group B: These companies are presently interested in computer people experienced in:

Computer maintenance
Systems engineering
Circuit design for computers
Operations analysis
Data reduction systems
Decimal to binary systems
Reliability analysis
Programming development
Sales engineering for the computer field

Experience levels for these positions ranged from two to five years of practical experience as a minimum, with a B.S. degree or its equivalent.

Group C: These companies are presently interested in people trained in:

Radar networks
Missile guidance systems
Missile detection networks
Communication systems
Language translation engineering
Analog to digital converters
Processing and simulation equipment
Surface to air control systems
Logical design of control systems
Radar circuitry
Data processing engineers

The range of industrial or practical experience needed for these positions is between three to seven years, with a B.S. degree or its equivalent.

Group D: These companies are presently interested in computer people having experience in:

Design of fundamental circuits for computers
Analog to digital converters
Memory circuit engineering
Research in information handling techniques, especially memory, retrieval, and display
Control monitoring and simulation
Communication system development
Maser and basic component design

The range of experience needed for these positions ranged from five to ten years of industrial or similar practical experience, with an advanced academic degree preferably in electrical engineering or in one of the physical sciences.

Computer Future Promising

In a time when four to seven percent unemployment is considered an inevitable consequence of our economic system, computer people can rejoice at the prosperity that the opportunities outlined here represent. Professional positions in the computer field have been continually increasing during the last five years; indications are that the development of the United States' national space program, and increased application of data processing systems to business will mean continual growth for the computer field, and for the computer people who build it.

BIBLIOGRAPHY ON HIGH SCHOOL MATHEMATICS EDUCATION

George E. Forsythe
Department of Mathematics, Stanford University
Stanford, California

The following list of books, articles, and related material was prepared for an informal local conference on the high-school mathematics curriculum. In spite of its incompleteness, the author hopes that readers may find it useful.

1. Why Study Mathematics and How?

The Canadian Mathematical Congress, WHY STUDY MATHEMATICS, 50 cents from the Canadian Math. Congress, Engineering Bldg., McGill Univ., Montreal P.Q., c. 1947

The following student material can be obtained free from Education Relations, Dept. 2-119, General Electric Co., Schenectady 5, New York:

THE THREE WHY'S (PRD-53); THE FOUR WHY'S (PRD-45); EVERYBODY USES MATHEMATICS (PRD-9A); WHAT DO YOU THINK ABOUT? (PRD-97).

H. M. Dadourian, HOW TO STUDY, HOW TO SOLVE, special student edition, paper bound, Addison-Wesley, 1949, 41 pp.

College Entrance Examination Board's Commission on Mathematics (425 West 117 St., New York 27, N.Y.)

OBJECTIVES OF THE COMMISSION ON MATHEMATICS, page 2

2. What is Mathematics?

College Entrance Examination Board, INTRODUCTORY PROBABILITY AND STATISTICAL INFERENCE FOR SECONDARY SCHOOLS, 182 pp., 1957. (Textbook for a proposed semester course for 12th grade, obtainable for $1.00 from 425 West 117th St., New York 27.)

Richard Courant and Herbert Robbins, WHAT IS MATHEMATICS? Oxford Univ. Press, 1941, 521 pp. (This is universally acknowledged by mathematicians to be excellent, and the best presentation of its kind. It is a possible 12th grade text, but pretty difficult.)

Arnold Dresden, AN INVITATION TO MATHEMATICS, Henry Holt, 1936, 453 pp. (A successful freshman college text for non-math-majors at Swarthmore; out of print?)

John E. Freund, A MODERN INTRODUCTION TO MATHEMATICS, Prentice Hall, 1956, 543 pp. (A possible 12th grade text, but perhaps less demanding.)

Glenn James (editor), THE TREE OF MATHEMATICS, Digest Press, 14068 Van Nuys Blvd., Pacoima, California.

John G. Kemeny, J. Laurie Snell, Gerald L. Thompson, FINITE MATHEMATICS, Prentice-Hall, 1957, 372 pp. (A very good possibility for 12th grade text.)

M. Kline, MATHEMATICS IN WESTERN CULTURE, Oxford Univ. Press, N.Y., 1953.

L. R. Lieber and H. G. Lieber, THE EDUCATION OF T. C. MITS, Norton, New York, 1942, 229 pp. (In verse with illustrations the authors tell the layman a great deal about mathematics, mainly pure. The compiler knows of no other popular book which conveys the flavor of mathematics so well. T. C. MITS is "the celebrated man in the street." Not a possible text. The Liebers have other books.)

H. Rademacher and O. Toeplitz, THE ENJOYMENT OF MATHEMATICS: SELECTIONS FROM MATHEMAT-

ICS FOR THE AMATEUR, Princeton Univ. Press, 1957, 204 pp., $4.50

M. Richardson, FUNDAMENTALS OF MATHEMATICS, revised edition, Macmillan, New York, 1958, 507 pp. (Full of problems and good references; quite a likely looking 12th grade text.)

3. Modern Applications of Mathematics.

E. F. Beckenbach (editor), MODERN MATHEMATICS FOR THE ENGINEER, McGraw-Hill, New York, 1956, 514 pp. (A survey of applied mathematics by research mathematicians, written for engineers. It will give you a pretty good idea of how mathematics has been evolving since 1940, in the applied directions.)

A. Charnes, W. W. Cooper, and A. Henderson, AN INTRODUCTION TO LINEAR PROGRAMMING, Wiley, New York, 1953.

R. Courant, DIRICHLET'S PRINCIPLE, Interscience Publ., New York, 1950.

C. Lanczos, APPLIED ANALYSIS, Prentice-Hall, 1956, 539 pp. (A monograph on numerical analysis; very enjoyable reading.)

J. F. McCloskey and F. N. Trefethen (editors), OPERATIONS RESEARCH FOR MANAGEMENT, Johns Hopkins Press, Baltimore, 1954. (A collection of articles.)

J. McDonald, STRATEGY IN POKER, BUSINESS, AND WAR, Norton, New York, 1950.

P. M. Morse and G. E. Kimball, METHODS OF OPERATIONS RESEARCH, Wiley, New York, 1950.

C. E. Shannon and W. Weaver, THE MATHEMATICAL THEORY OF COMMUNICATION, Univ. of Illinois Press, Urbana, 1949 (Information theory).

J. D. Williams, THE COMPLEAT STRATEGYST, McGraw-Hill, 1954, 234 pp. (An amusing and valuable introduction to the theory of games.)

4. Automatic Digital Computers and their Programming.

Anonymous, HOW THE COMPUTING SYSTEM WORKS FOR YOU, Management Services and Operations Research Dept., Remington Rand Univac, 2300 West Allegheny Ave., Philadelphia 29, Penna.

E. C. Berkeley and L. Wainwright, COMPUTERS—THEIR OPERATION AND APPLICATIONS, Reinhold, New York, 1956 (popular).

W. J. Eckert and Rebecca Jones, FASTER, FASTER, McGraw-Hill, New York, 1955, 160 pp. (An elementary description of NORC ,the largest and fastest computer at the time, and the problems it solves.)

S. Gorn and W. Manheimer, THE ELECTRONIC BRAIN AND WHAT IT CAN DO, Science Research Associates, Inc., 57 W. Grand Ave., Chicago 10 (written for school pupils).

International Business Machines Corp., 650 MAGNETIC DRUM DATA-PROCESSING MACHINE, (how to code problems for IBM's most wide-spread automatic computer; obtainable from IBM Corp).

D. D. Livesley, AN INTRODUCTION TO AUTOMATIC DIGITAL COMPUTERS, Cambridge, England, 1957.

D. D. McCracken, DIGITAL COMPUTER PROGRAMMING, Wiley, New York, 1957, 253 pp. (the first textbook on programming; recommended for high school and junior college teachers).

Richard V. Andree, PROGRAMMING THE IBM 650 MAGNETIC DRUM COMPUTER AND DATA PROCESSING MACHINE, Henry Holt, 1958, 109 pp. (This appears to be an excellent textbook, well suited to the beginner.)

Stanford Computation Center, I. BELL FLOATING - DECIMAL INTERPRETIVE SYSTEM. II. INTERNAL TRANSLATOR (IT), obtainable from student book store, Stanford University, Stanford, Calif. (Special techniques for coding more easily for the 650; presumes no knowledge of basic machine language.)

G. R. Stibitz and J. A. Larrivee, MATHEMATICS AND COMPUTERS, McGraw-Hill, New York, 1957, 228 pp. (A brave attempt to describe to the intelligent layman what computers and their uses are all about. There is also a considerable bibliography of articles in many fields, including several on teaching about computers in high school.)

M. V. Wilkes, AUTOMATIC DIGITAL COMPUTERS, Wiley, New York, 1956, 305 pp.

5. Pure Mathematics.

While in high school, most students will probably learn little from the books in this group. However, most schools will now and then have an unusually gifted student, and it is essential to have books waiting for him. His interest in mathematics should be stimulated, whether or not his mathematics teacher realizes his talents. Griffin is a book which many students will profit from.

Garrett Birkhoff and Saunders MacLane, A SURVEY OF MODERN ALGEBRA, Macmillan, New York, 1941, 450 pp.

R. Courant, DIFFERENTIAL AND INTEGRAL CALCULUS, Translated by E. J. MacShane, 2 volumes, Blackie & Sons, 1934 and 1936.

William Feller, AN INTRODUCTION TO PROBABILITY THEORY AND ITS APPLICATIONS, Vol. 1, Wiley, New York, 1950, 419 pp.

F. L. Griffin, INTRODUCTION TO MATHEMATICAL ANALYSIS, Houghton Mifflin, Boston, 1921. (This would make a possible textbook in introductory calculus.)

G. H. Hardy, A COURSE OF PURE MATHEMATICS, 10th Edit., Cambridge Univ. Press, 1952, 509 pp.

6. Mathematical Contests.

B. V. Gnedenko, MATHEMATICAL EDUCATION IN THE U.S.S.R., Amer. Math. Monthly, vol. 64 (1957), pp. 389-408 (contains a syllabus of Soviet education, as well as selected high school contest problems and training problems for the contests).

Anonymous, EIGHTH ANNUAL MATHEMATICS CONTEST, sponsored by Metropolitan New York section of Mathematical Association of America, perhaps obtainable from Committee on Mathematics Contests and Awards, Polytechnic Institute of Brooklyn, Brooklyn 1, New York. (This is an actual examination paper.)

Similar contest material may be obtainable from Prof. Maurice Beesley, Math. Dept., Univ. of Nevada, Reno; from Prof. F. L. Bedford, Phoenix Coll., Phoenix, Ariz.; and from Prof. G. Szego, Dept. of Math. Stanford University, Stanford, Calif.

7. Puzzles

Anonymous, THE LITTLE PUZZLE BOOK, Peter Pauper Press, Mt. Vernon, New York, 1955, 62 pp.

W. W. R. Ball and H. S. M. Coxeter, MATHEMATICAL RECREATIONS AND ESSAYS, Macmillan and Co., London.

H. E. Dudeney, AMUSEMENTS IN MATHEMATICS, Thos. Nelson & Sons, New York, 1917.

G. Gamow and M. Stern, PUZZLE-MATH, The Viking Press, 1958.

R. V. Heath, MATH-E-MAGIC, reprint, Dover, New York, 1953, 126 pp.

S. I. Jones, MATHEMATICAL CLUBS, NUTS AND WRINKLES, 1122 Belvedere, Nashville 4, Tenn.

G. L. Kaufman, THE BOOK OF MODERN PUZZLES, 2nd edit., Dover, New York, 188 pp.

Maurice Kraitchik, MATHEMATICAL RECREATIONS, 2nd edit., Dover, New York, 1953, 330 pp. (more advanced).

Geoffrey Mott-Smith, MATHEMATICAL PUZZLES FOR BEGINNERS AND ENTHUSIASTS, 2nd edit., Dover, New York, 1954, 248 pp.

E. P. Northrop, RIDDLES IN MATHEMATICS, D. van Nostrand and Co., New York, 1944.

H. Steinhaus, MATHEMATICAL SNAPSHOTS, Stechert, New York, 1938.

LOS ANGELES MATHEMATICS NEWSLETTER, obtainable through Math Dept., L.A. City College, 855 N. Vermont Ave., Los Angeles 29. (This contains articles, puzzles and student solutions, all for the high school student.)

THE MATHEMATICAL LOG, published by Mu Alpha Theta, The National High School and Junior College Mathematics Club, obtainable from Box 1125, University of Oklahoma, Norman, Oklahoma, probably as a privilege of membership.

O. U. MATHEMATICS LETTER, published quarterly by the Department of Mathematics and Astronomy, Univ. of Oklahoma, Norman, Oklahoma, now in its sixth year. (This is apparently aimed more at college students than high-school students, but would be well worth having. Subscription is 35 cents per year each, for 3 to 10 subscriptions.)

8. Miscellaneous Books for Students and Clubs

Edwin A. Abbott, FLATLAND, 6th edit., Dover, New York, 1952, 103 pp. (Understanding four dimensions by reading how a two-dimensional world looks to three-dimensional folk, and vice versa.)

E. T. Bell, MEN OF MATHEMATICS, Simon & Schuster, New York, 1937.

R. Dubisch, THE NATURE OF NUMBER, Ronald Press.

J. Newton Friend, NUMBERS, FUN AND FACTS, Scribner, New York, 1954, 208 pp.

Helen Fouché Gaines, CRYPTANALYSIS, Dover, New York, 1956, 237 pp.

Fletcher Pratt, SECRET AND URGENT, THE STORY OF CODES AND CIPHERS, Blue Ribbon Books, 1942, 282 pp.

W. J. Reichmann, THE FASCINATION OF NUMBERS, Essential Books, 1957, 176 pp.

Robert L. Swain, UNDERSTANDING ARITHMETIC, Rinehart, New York, 264 pp. (Explains the number system.)

Dirk J. Struik, A CONCISE HISTORY OF MATHEMATICS, Dover, New York, 1948, 299 pp. in two volumes.

Mu Alpha Theta (national high school and jr. college math club, founded by Pi Mu Epsilon. Address: Box 1127, Univ. of Okla., Norman, Okla.)

MATHEMATICS STUDENT JOURNAL, first issue to appear in late 1958, edited by W. W. Sawyer, University of Illinois, Urbana, Ill.

9. For the Teacher

H. Martyn Cundy and A. P. Rollett, MATHEMATICAL MODELS, Clarendon Press, Oxford, 1952, 240 pp.

F. Klein, ELEMENTARY MATHEMATICS FROM AN ADVANCED STANDPOINT, 2 volumes, Macmillan, New York, 1932 and 1939. (Written by the famous German geometer for secondary school teachers.)

G. Polya, HOW TO SOLVE IT, Doubleday Anchor Books, New York, 1957, 253 pp. (A wonderful book by a wonderful teacher and teacher of teachers.)

G. Polya, INDUCTION AND ANALOGY IN MATHEMATICS. MATHEMATICS AND PLAUSIBLE REASONING, vol. 1, Princeton Univ. Press, 1954, 280 pp.

G. Polya, PATTERNS OF PLAUSIBLE INFERENCE. MATHEMATICS AND PLAUSIBLE REASONING, vol. 2, Princeton Univ. Press, 1954, 190 pp.

REPORT OF SUBCOMMITTEE ON CONTENT AND SEQUENCE OF MATHEMATICS FROM THE NINTH THROUGH THE FOURTEENTH GRADES, May 3, 1957, perhaps obtainable from Dr. John Lombardi, L.A. City College, 855 N. Vermont Ave., Los Angeles 29.

Ten Participating Teachers, INTRODUCTION TO ARITHMETIC COMPUTERS, A REPORT TO THE HUGHES AIRCRAFT COMPANY, Hughes Aircraft Co., Culver City, Calif., Dec. 1956, 29 pp. (What 10 teachers learned about computers in a summer.)

Ten Participating Teachers, TEACHERS-IN-INDUSTRY, Hughes Aircraft Co., Culver City, Calif., Sept. 1956, 29 pp. (What 10 teachers did and learned during a summer at Hughes, as written by themselves.)

THE LEXINGTON PLAN, brochures describing another plan for having high school teachers work alternate semesters in industry, obtainable from Arthur D. Little, Inc., 30 Memorial Dr., Cambridge 42, Mass., and from Raytheon Mfg. Co., Waltham 54, Mass.

10. Miscellaneous

The College Entrance Examination Board's Commission on Mathematics (425 West 117th St., New York 27, N.Y.) has published some material, and is preparing a great deal more, especially teaching materials. The following are available:

OBJECTIVES OF THE COMMISSION ON MATHEMATICS (an excellent statement of the problem and their program for a solution).

THE EDUCATION OF SECONDARY MATHEMATICS TEACHERS (both in-service and pre-service).

Albert E. Meder, Jr., MODERN MATHEMATICS AND ITS PLACE IN THE SECONDARY SCHOOL.

University of Illinois, Committee on School Mathematics, 1208 W. Springfield, Urbana, Illinois, under the leadership of Prof. Max Beberman, has been working for five or six years on a completely new high school math curriculum. This seems to the compiler to be the most significant experiment in the country. Eventually four years of materials should be available. At present there is only the challenging:

HIGH SCHOOL MATHEMATICS — FIRST COURSE, 1957-1958, available to individual teachers at $6.00.

MATHEMATICS TEACHER (increasingly valuable).

1957 Yearbook of National Council of Teachers of Mathematics (and other years).

The President's Committee on Scientists and Engineers, Washington 25, D.C., serves as a clearing house for ideas on stimulating a higher production of scientists. They publish a number of interesting brochures for students and others, and have an interesting Local Action Kit for any person interested in prodding his community to action in education.

P. Brock, MATHEMATICS AND AUTOMATA, Math. Teacher, Vol. 47 (1954), pp. 514-519.

Dyer, Kalin, and Lord, PROBLEMS IN MATHEMATICAL EDUCATION, Educational Testing Service, Princeton, N.J., (1956) (statement of problems, large bibliography, need for research and experiment in new curricula)

T. C. Fry, MATHEMATICS AS A PROFESSION TODAY IN INDUSTRY, Amer. Math. Monthly, vol. 63 (1956), pp. 71-80 (what positions there are, and how it is even more important to formulate problems than to solve them).

J. W. Gardner, A NATIONAL WEAKNESS, Amer. Math. Monthly, vol. 63 (1956), pp. 396-399 (the status of mathematics education in schools).

F. Gruenberger, PRESENT-DAY ACTIVITY IN NUMERICAL ANALYSIS, Math. Teacher, vol. 48 (1955), pp. 255-256.

A. S. Householder, MATHEMATICS, THE SCHOOLS AND THE ORACLE, Math. Teacher, vol. 48 (1955), pp. 299-304. (Why computers are important, and why they will not make mathematics obsolete. Square root is discussed in detail.)

S. MacLane, THE IMPACT OF MODERN MATHEMATICS ON SECONDARY SCHOOLS, Math. Teacher, vol. 49 (1956) ,pp. 66-69. (A simple explanation of the real importance of algebra, trigonometry, and geometry in modern mathematics.)

W. Manheimer, DIGITAL COMPUTER: CHALLENGE TO MATHEMATICS TEACHERS, School Science and Math., vol. 54 (1954) pp. 701-

G. Polya, ON THE CURRICULUM FOR PROSPECTIVE HIGH SCHOOL TEACHERS, Amer. Math. Monthly vol. 65 (1958), pp. 101-104. (The outline of Polya's course for teachers and prospective teachers, with a good deal of advice on teaching mathematics.)

M. D. Schaughency, TEACHING ARITHMETIC WITH CALCULATORS, Arith. Teacher, vol. 2 (1955), pp. 21-22.

N. Snow, MATERIALS FOR TEACHING CALCULATING MACHINE COURSES, Business Education Weekly vol. 35 (1955), April, pp. 21-

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Robert A. Rosenbaum and Louise J. Rosenbaum, BIBLIOGRAPHY OF MATHEMATICS FOR SECONDARY SCHOOL LIBRARIES, Dept. of School Services and Publications, Wesleyan University, Middleton, Conn., 1957, 17 pp. (A list of over 100 books for the high school library, with a recommendation of the first 12 to buy, the next 13, etc. The present author feels that every high school library should have all the books. The combined cost is probably less than $1000; what $1000 worth of teacher has so much information?)

Anonymous, MATHEMATICS BOOKLIST FOR HIGH SCHOOL LIBRARIES 1958, mimeographed, National High School and Junior College Mathematics Club, Box 1127, The University of Oklahoma, Norman, Oklahoma, 2 pp. (A list of approximately 40 books, arranged in groups of about $25 to $30 value, with priorities. Also listed are eight mathematics periodicals and some general references. Prof. R. V. Andree is the compiler or a co-compiler of the list.)

Logic, Common Sense, and Social Responsibility of Computer Scientists — Controversy

Neil Macdonald, Charles H. Johnson, and others

I. From Neil Macdonald

New York, N.Y.

To the Editor:

In **Computers and Automation** for May, 1958, you published my article "An Attempt to Apply Logic and Common Sense to the Social Responsibility of Computer Scientists." Later, you gave permission with my consent for the **Journal of Machine Accounting** at their request to reprint a part of it, which they did in their December 1958 issue, to the extent of some fifteen paragraphs (out of the 70 odd paragraphs in the original article).

In their December issue, the editor of the **Journal of Machine Accounting**, Mr. Charles H. Johnson, also published some five paragraphs of rebuttal headed "Editor's Comments." This, of course, is a good thing to do, because discussion and argument are desirable.

Upon reading this, however, I promptly wrote him, pointing out that he had misquoted and misrepresented what I had said. At the end of January, he replied (to you, not to me), refusing to publish my letter or any more of the article, or any correction or any straightening out of the record (except for one trivial point). It seems to me that this procedure is thoroughly unfair and un-American.

What he did find room for was eight lines in the February issue of the **Journal of Machine Accounting** for a notice correcting the spelling of my last name — which is an utter triviality and is like a slap in the face, when there are much more important questions at issue. I therefore ask you for some space in **Computers and Automation** to put the record straight with the hope that at least some readers of the **Journal of Machine Accounting** will notice that their own journal refuses to give them the whole story, and will be able to decide for themselves with all the information in front of them.

II. Letter from Neil Macdonald to Charles H. Johnson, Editor of the Journal of Machine Accounting, December 24, 1958:

I am glad that you found my article "An Attempt to Apply Logic and Common Sense to the Social Responsibility of Computer Scientists" published in the May 1958 issue of **Computers and Automation** interesting and worth inviting discussion in the pages of the **Journal of Machine Accounting** for December 1958.

But I must protest to the utmost:

(1) That by omitting many very important parts of my article, you have produced an impression not in agreement with the impression produced by the whole article.

(2) That you have garbled even what you did quote — on page 35, left-hand column, for example, you have destroyed a good deal of the meaning by putting 5 paragraphs out of sequence (the last 5 paragraphs precede the 6th paragraph as the words "end of quote" suggest). Your readers must be confused if you so obviously misquote in this fashion.

Second, I must protest to the utmost in regard to many of your comments on my article. For example:

> "Mr. Macdonald is presumptuous in his findings for he assumes that the computer scientist can by his behavior regulate the behavior of the rest of the world."

But I do not make that assumption, and a careful reading of my whole article shows that I do not.

You say:

> "If as Mr. Macdonald suggests, computer scientists can guarantee and enforce the principles of behavior which assures [sic] all nations justice and peace, then and only then would it be desirable to place the responsibility of world behavior in the hands of the computer scientist."

But I do not make this suggestion nor do I advocate that computer scientists "guarantee or enforce the principles of behavior."

You say:

> "Computer scientists should not be deluded by such theories."

But I am not advocating that any one should be "deluded" by any theory or any other statement.

In many other places besides these, you misquote, or fail to understand precisely what I have said.

It seems to me that you follow the well-known and often-used plan of attack by people on arguments they don't like, by:

(1) asserting that an adversary says what he does not say, and then

(2) proving that the misquoted statement is false or stupid or bad.

This kind of attack on an argument is not fair and is not scientific and is not logical.

The subject of the social responsibility of computer and other scientists is very important. It must be discussed fairly and scientifically and logically — and not with misquotations, misunderstanding, misattributings.

I enclose a reprint of my article in which I have marked a number of places which show how the impression I wished to make has been distorted by your omissions.

I therefore insist and demand that you print my entire article accurately in the earliest possible issue of your Journal, so that your readers may know exactly what I have said. In a subject as important as this, I cannot afford to be misquoted or misunderstood. I also insist and demand that you print this letter in full and accurately in the next issue of the Journal, so that your readers may know exactly what I have said in this letter. And please note that my name is spelled "Macdonald" with a small "d" in the middle, in line with American and not Scotch spelling.

III. Letter from Charles H. Johnson, Editor of the Journal of Machine Accounting, January 26, 1959, to E. C. Berkeley:

In answer to your and Neil Macdonald's letters. Upon receiving Mr. Macdonald's letter, I very conscientiously reviewed the article in question and came up with the same conclusions I previously had. Not being satisfied, I passed the original article, the Journal editorial, and the letter from Neil Macdonald to the Advisory Board of the Journal, and to two engineers and asked for their comments.

Without going into detail, the general gist of their comments is this. Upon reading Neil Macdonald's article, you are left to draw your own conclusions as to what his opinion really is. If you rely on the quotations and on the general impression the article gives you, there is only one conclusion that you can come to and that is the conclusion stated in the Journal editorial.

We are always tight for space in the Journal. We haven't anywhere near enough room for everything we would like to print. This is the reason we did not and will not print the article in its entirety. Furthermore it seems to me that if I were a reader of the Journal and became interested in Mr. Macdonald's complete article, I would want to buy the magazine in which it was printed. Need I say more! . . .

We are running an apology on the misspelling of Macdonald's name in the Journal. . . .

Once again, let me clearly state our position. We feel upon the information supplied to us in the article we could only come to one conclusion, though apparently the original article does not clearly state Macdonald's thinking. He obviously does not arrive at the same conclusion other people have upon reading the article.

Further than this we don't believe any editor can expect everyone to agree with the editorials we write, but we still believe it is incumbent upon an editor to write his opinions whenever he feels it is of sufficient interest to his readers.

We write this letter with a feeling of regret that Neil Macdonald does not fully comprehend the reason for the editorial comment.

IV. From Neil Macdonald

First: My original article contains very clearly two stated conclusions. I quote:

(1) "And so we arrive at the proposition that it seems to me we have to support: Computer scientists have a special social responsibility more than and in addition to the responsibilities of most other scientists and citizens — the responsibility of the locksmith." [The article also remarks that "three groups of scientists play the role of locksmith."]

(2) "And if a single computer scientist has trouble thinking all this out logically, then let's have a committee of computer scientists to get together and think this out, and study the social responsibility of computer scientists with due regard to objective evidence, the toughest of sound logic, and the most practical of common sense."

With regard to this second conclusion, that proposal has now happened: a committee of computer scientists has done just this. In the February 1959 issue of **Computers and Automation** has been printed a report by the Association for Computing Machinery Committee on Social Responsibility of Computer People.

My article does contain conclusions, and they are not in the least the conclusions cited in the "Editor's Comments" by Mr. Johnson in the December 1958 issue of the **Journal of Machine Accounting.**

Second: Mr. Johnson in his letter of January 26 takes the extraordinary position that prosecutor and judge should be the same person, when he is an editor.

On the contrary, when an editor finds that some reader challenges the comments that he, as editor, has made, then he must in fairness to his audience present that reader's challenges.

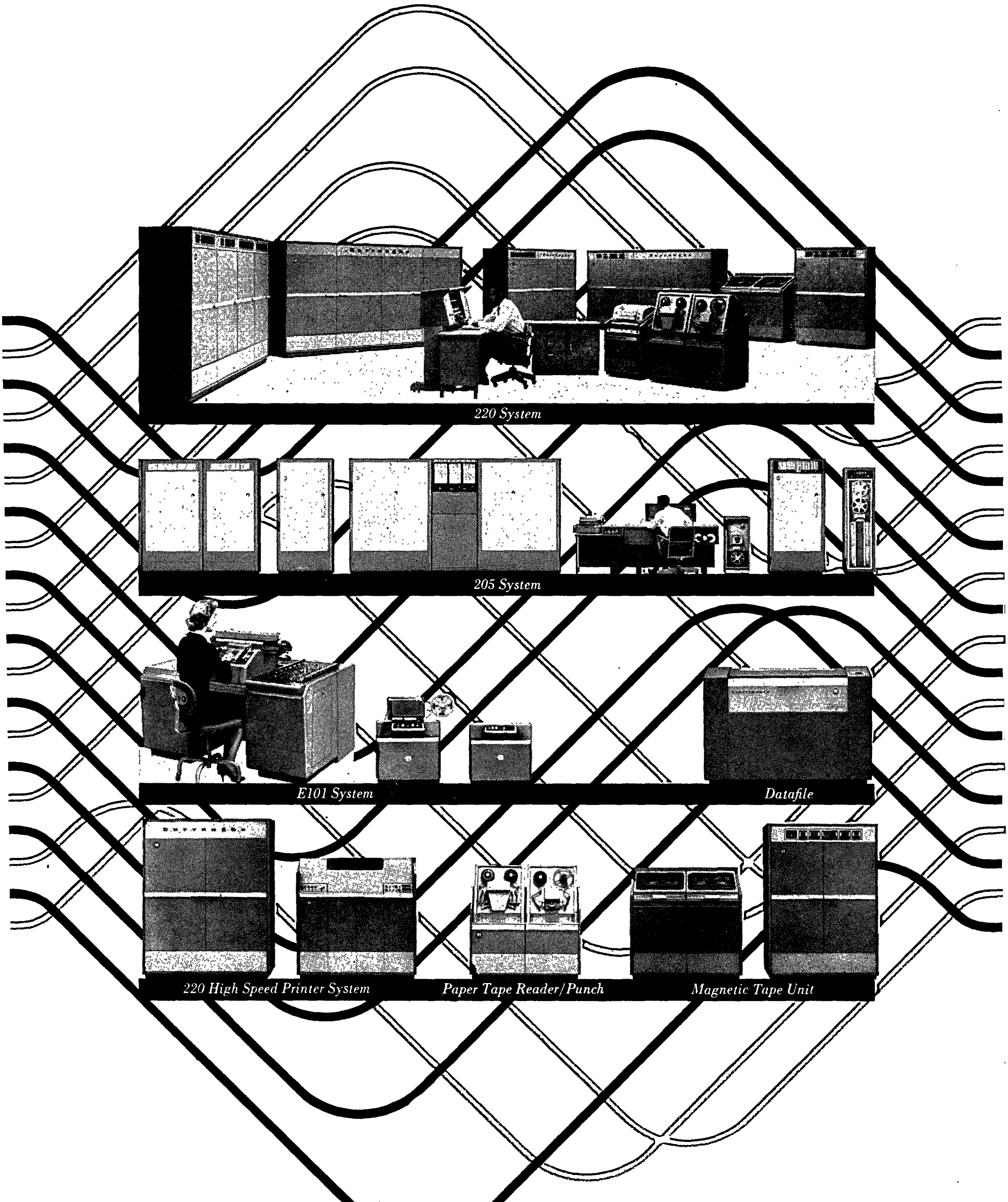
Third: Mr. Johnson says "We don't believe any editor can expect everyone to agree with the editorials that he writes, but we still believe it is incumbent upon an editor to write his opinions whenever he feels it is of sufficient interest to his readers." This is, of course, true, but has nothing to do with the question at issue.

For, *after* an editor makes his comments, the person who is the subject of his comments must have the right to discuss and dispute the comments — to put in front of the readers of the magazine, for example, the argument that the comments are based on misunderstanding, misquoting, and misrepresentation, of course offering evidence for his argument. Then we have controversy, and out of that crucible we hope comes some heat, much light, and more understanding.

V. From the Editor

The policy of **Computers and Automation** will always be: If we have made a mistake, we shall publish a correction. If we have failed to give some one a hearing, we shall give him a hearing. If we have discussed a subject in an editorial, and some one disagrees with the comments in that editorial, we shall publish that disagreement. We believe in discussion, argument, and controversy, in the computer field and in other fields, and we do not believe that the editor is always right nor always able to determine when he is right!

We shall be glad to send to anyone on request a reprint of the full article "An Attempt to Apply Logic and Common Sense to the Social Responsibility of Computer Scientists" by Neil Macdonald, published in the May 1958 issue of **Computers and Automation.**



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Memory Size — 4,096 to 16,384 words

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Conservative-peak rate is 160,000 per second.

Highest speeds available in a moderately priced system.

One 2,500 ft. reel will hold 4,500 400-word records.

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INDUSTRY NEWS NOTES

FRONTIER RESEARCH IN COMPUTERS

In 1959, the Consolidated University of North Carolina, Chapel Hill, N.C., will install one of the largest digital computers being used for research and education in any university, the Remington Rand Univac Scientific 1105. Purchase of this machine was made possible through the support and cooperation of the Sperry-Rand Corporation, the Bureau of the Census, and the National Science Foundation.

Although the computer itself is located on the campus in Chapel Hill, it will be used by students and faculty of the North Carolina State College in Raleigh and the Woman's College of the University of North Carolina as well. Plans are underway to make time available on a cooperative basis to other nearby institutions, both in North Carolina and the Southeastern United States.

In addition to serving as a teaching and research aid in present university areas, it is planned to use the computer as a research tool in such frontier areas as language translation, automatic programming, automatic numerical analysis, new problems of business, statistical and other data processing, linguistics analysis, numerical solution of partial differential equations, mathematical logic and decision processes, and many other regions of investigation that have become important only since the advent of the high-speed digital computer.

In August, the Research Computation Center, with the cooperation of several other departments of the University, will give several courses in digital computers. Two of these courses are:

1. *Frontier Research in Programming and Artificial Intelligence:* New theory and techniques in the sophisticated use of digital computers for basically noncalculational purposes. Use of digital computers for attacks on large and complex problems.

The following lecturers are among those who have been invited:

Prof. Alan J. Perlis, Carnegie Institute of Technology, Pittsburgh, Editor of the *Communications* of the Association for Computing Machinery, and developer of the IT Compiler.

Prof. Marvin Minsky, Mass. Inst. of Techn., Cambridge, Mass., author of papers on "artificial intelligence" and its applications in the field of digital computers.

Philip Dreyfuss, Compagnie des Machines Bull, Paris, designer of the Bull Gamma-60 "concurrent" computer.

Prof. Saul Gorn, University of Pennsylvania, Philadelphia, currently heading research on a common computer language for the U.S. Army.

Heinz Schecher, Munich Technische Hochschule, Munich, originator of "indirect addressing" and designer of the computer PERM.

Prof. John W. Carr III, Research Computation Center, University of North Carolina.

In addition representatives of computer manufacturers will be invited to report on their latest researches; also, Dr. A. P. Ershov, author of the compilers for the Soviet Computers BESM and Strela, will be invited to lecture in this course if circumstances permit.

2. *Frontier Research in Numerical Analysis for Computers:* Recent developments in numerical analysis, based both on theoretical considerations and experiences in actual computation at leading centers.

The following lecturers are among those who have been or will be invited:

Dr. R. W. Hamming, Bell Telephone Laboratories, Murray Hill, N.J.

Prof. David Young, Director, Computation Laboratory of the University of Texas, formerly Ramo-Wooldridge Corporation.

Dr. Heinz Rutishauser, Eidgenoessische Technische Hochschule, Zurich, Switz.

Dr. Jack Moshman, Corporation for Economic and Industrial Research, Washington, D.C.

Prof. John W. Carr III, Research Computation Center, University of North Carolina.

Prof. L. V. Kantorovich of Leningrad University, a leading authority on linear programming, functional analysis, and numerical analysis will be invited to lecture in this course, if circumstances permit.

"WE ARE ONLY ON THE THRESHOLD OF DEVELOPMENT IN NAVAL MATHEMATICS"

A new computer system of very high speed and with 32,000 words of rapid memory was installed in the Applied Mathematics Laboratory at the David Taylor Model Basin, Washington, D.C., October, 1958. On that occasion Captain A. E. Wright, Director, said:

"We are only on the threshold of development in naval mathematics. The teamwork of mathematicians, theorists, and naval engineers is discovering unsuspected areas for systematizing scientific and design calculations. From calculating pipe stresses to calculating potential flow patterns around submerged bodies, from decompression tables to radioactivity levels, from machinery vibration to casualty rates for electronic components, and from extrapolation of ship model observations to analysis of fuel rates for ships of the U. S. Navy, the scope of naval mathematics ever widens. The workhorses of this numerical revolution are the universal computers,

which are each the equivalent of more than 1000 skilled human beings with desk calculators. The computers produce a full work-week, require no sick or annual leave, make few mistakes and have excellent memory, have comparatively few management problems, and do not even take a coffee break."

The Applied Mathematics Laboratory has been a pioneer in the use of computers for the solution of naval problems in the fields of engineering, research, management, and operations research, including: the design of nuclear reactors for ships such as the NAUTILUS and the SEA WOLF; calculation of propellor characteristics; the analysis of collapse-pressures of submarine hulls; and the calculation of scheduled material requirements in shipbuilding programs, as well as many other applications.

AUTOMATIC PROGRAMMING FOR BENDIX G 15

A new automatic system for computer programming enables relatively untrained personnel to operate the general purpose digital computer Bendix G 15.

It is called POGO standing for "Program Optimizer for G 15 Operations."

The human programmer, following simplified instructions, writes a preliminary POGO program. When these instructions are fed into the computer, the machine rewrites the program in its own machine language instructions. It then selects an ideal memory location in which to store each instruction, so that processing time is conserved.

Once the computer finishes rewriting its instructions, the preliminary program is discarded. The rewritten program is recorded on tape, and can be used again and again to solve the same problem with different input conditions.

Technically, POGO is a compiler that operates on fixed point numbers. Data is handled in decimal form, with numbers of seven digits, positive and negative. Seventeen accumulator registers are available, and a scale factor is specified in the instruction code. Twelve index registers are provided for use in modifying the effective addresses on which the instructions act.

THE COMPUTER AND THE HIGHWAY PATROL: A NEW TEAM IN ILLINOIS

The speed of electronic data-processing has caught up with — and passed — the speeding motorist. An electronic data-processing system for driver licensing and control over drivers has been operating for nearly a year in the State of Illinois. Because the system swiftly handles information about convictions for traffic law violations, accidents, and examination failures, faster action can be taken against drivers whose records show they are a continual source of danger on the highways. Secretary of the State of Illinois, Charles Carpentier, has declared that the system provides constant supervision, control, and education of drivers, thereby reducing motor vehicle accidents.

Each driver's record has a distinct place in the master tape file of the IBM Tape 650 system. Information can be fed into the file via punched cards at the rate of two hundred a minute. Simultaneously using another tape, the computer analyzes the overall record of the driver, and records on a second tape necessary warnings, suspensions, revocations, and cancellations (subject to review by a human being), and produces a new abstract of records. The system's magnetic tape memory has a speed of 15,000 characters a second; each 2,400 feet of tape stores over 5,000,000 characters.

The accessibility of license information allows Illinois to adopt a permanent driver license number that establishes positive identification of the person to whom the license was issued. The combination of the number for positively identifying drivers and the electronic data processing system has enabled the Drivers License Division to consolidate 13 former files into a single present file.

The importance of the new system is indicated by 1957 statistics: 2,380,000 license applications were processed; 675,000 license examinations were given; 726,000 reports of traffic violation convictions were received; 400,000 accident reports were received; and 1,000,000 drivers' records were watched because of earlier traffic violations.

OPTIMUM DESIGN OF TRANSFORMERS

H. J. Weber and George Gallousis
Allis Chalmers Mfg. Co.
Pittsburgh, Pa.

(Based on a report to the Fall General Meeting of the Amer. Inst. of Electrical Engrs.)

An electronic computer is capable of insuring a mathematically perfect and consistent line of standard transformers.

Our firm has underway a program in which the computer supplies the design engineer with the best possible initial design for the transformer, after the computer is given a description of the transformer in a mathematical form incorporating every variable influencing the cost and the design. In order to make the design practical and ready for production, the engineer then replaces the continuous variables with the nearest standard sizes. The final result is a practical optimum design, the cost of which is only slightly above that of the theoretically optimum design.

Rather soon the computer program will be made more general so that the machine will choose standard sizes to provide the optimum practical design automatically.

As a result, sales engineers can be quickly supplied with quotation information. Also, theoretical studies can be made concerning the influences on cost of varying the losses, impedances, audio noise levels, materials, and prices.

By using the computer to vary certain parameters while others are held constant, it is possible to determine with exactness the interrelation of parameters. The data thus obtained, when evaluated and correlated with actual test or field experience, can be used to modify or refine presently accepted design formulas or concepts, or to establish new approaches to design problems.

READING, WRITING, AND ARITHMETIC — AND AUTOMATION

Henry D. Billings
Springfield, Mo.

Your readers may be interested in some remarks about automation and the education of human beings, made by Ray Mertes of United Airlines recently in a speech here before the Community Teachers Association.

"Automation is anything but an automatic recess from necessity of teaching reading, 'riting, and 'rithmetic," he said.

Mr. Mertes, a teacher and school administrator himself for 14 years, is director of school and college services for United's public relations department.

He is undismayed by someone's statement that "the industrial revolution devaluated man's ability to use his arm; automation will devaluate man's ability to use his brain."

He cited United's Ramac computer for reservations records.

"It can memorize five million names, dates, and destinations and regurgitate the whole mess back at you; or any part of it.

"If you want to know how many people flew to Hawaii, you push the Hawaii button.

"But suppose the poor guy can't spell Hawaii. He might push the Washington button. You'd get the information on Washington instead of what you wanted, wouldn't you?

"This machine's only about a year old," Mertes continued, "and already we have another one ordered which can do the same thing, in one-tenth the time, one second."

"And we'll probably spend a lot of money teaching the people who will have anything to do with the new machine that the most important thing about running it is Y-O-U."

LEHIGH UNIVERSITY COMPUTING LABORATORY

William A. Smith, Jr.
Director, Computing Laboratory and
Assistant Professor of Industrial Engineering
Lehigh University
Bethlehem, Pa.

We enjoyed reading in your February issue about our approach to the education of undergraduates in computing, and I thought you might be interested to know that the introductory course in programming mentioned in the article has been better received than anticipated. Although designed to be taught every other semester, the demand has been sufficient in the last two years to necessitate teaching it every semester. As a matter of fact, in the first semester that it was *not* offered, enough people registered for the course so that eventually two sections were formed. This course does not deal entirely with the LGP-30, but it includes the comparison of coding techniques for that computer, the IBM 650 and Univac II.

The seminars conducted by Computing Laboratory personnel have blossomed into specific training programs for faculty and staff members. In addition to the departments mentioned in the article, personnel from the following areas of interest have participated in these programs: Chemical Engineering, Civil Engineering, Chemistry, Industrial Engineering, Mechanics, Electrical Engineering, Physics, Psychology, Metallurgical Engineering, Mathematics, and Mining Engineering.

Since the time when the material was gathered for the article, we feel we have been able to reach quite a few undergraduates in many courses of study through the medium of the computer programming course, and even more importantly by demonstrating the solution of typical problems to classes not directly related to computer training.

Readers' and Editor's Forum

[Continued from page 6]

The above definitions may not be sufficiently rigorous for ultimate use, but at least they suffice to indicate the major types of machine tool control equipment in terms of their basic functions. Some commonly encountered terms, such as "interpolator," "director," "planning desk," "programmer," have been avoided deliberately, since they merely reflect a variety of the individual proprietary approaches to the same basic functions. Once the nature of any such specific equipment item is known it readily falls into one of the types identified above. I do not believe the same is true of the listings you printed in your November 1958 issue (cf. "machine tool direction center" *vs.* "machine tool tape producing machines").

II. From the Editor

This is a useful correction and amplification of our list, and we welcome it.

IRRATIONALITY

Mrs. P. Cammer
Huntington, L.I., N.Y.

The February issue of **Computers and Automation** is very interesting and as usual provocative. The ACM committee report on the social responsibility of computer people is EXCELLENT; I hope much comes of it. Why don't the rocketeering people, like the atomic scientists and the computer scientists, begin to blast themselves out of their rut, and start to look at their social responsibility? I think Neil Macdonald's article "Opposition to New Ideas" is so right; it must have a few faults but I don't see any.

But the biggest problem which I see now, and which I do not believe **Computers and Automation** has given enough attention to, is irrationality. Of course, some irrationality will always be present among people; but the present level of irrationality is so unnecessarily, ominously high, due to misplaced fears.

What is urgently needed now is the cessation of self-defeating, irrational policies. For example, what will it profit a computer engineer to make a marvelously efficient guidance mechanism for a missile with a nuclear warhead, if two minutes after that missile is launched, a retaliatory missile is launched from the opposite country, blasting him and several million of his nearby fellow citizens into radioactive dust?

I believe it can be proved that present-day wars are far more disastrous to the groups that would encourage them than would be the conditions brought about by peaceful change.

So the big problem now is how to apply solutions in spite of all the obstructions by all these groups.

Many exquisitely competent computers are being used for jobs which are entirely irrational. The time is ripe for computer people and other highly trained people to stop aiding irrationality, and instead work to have their powerful devices used in the service of reason. The issue can be argued of course if looked at narrowly. But if viewed broadly on a world wide scale, where is the argument?

COMPUTER TALKS

Joint Automation Conference, Chicago, Ill.
May 11 to 13, 1959

Application of Data Logging and Programming Techniques to Steel Mill Processes / R. W. Barnitz, Chief Electrical Engineer, Jones & Laughlin Steel Corp., and G. E. Terwilliger, Metal Rolling and Process Engineering, General Electric Co.

Shaping Steel in a Programmed Mill / H. G. Frostick, U.S. Steel Corp.

Productivity Improvement through Automatic Control Techniques / C. Zimmerman, American Steel and Wire Div., U.S. Steel Corp.

Financial Justification of Automatic Machines / W. W. Kuyper, Large Steam Turbine Dept., General Electric Co., New York

Application of Numerical Control for Automatic Manufacturing in General Industry / W. E. Brainard, Kearney & Trecker Corp., Milwaukee

Static Control and Automatic Transmissions / C. N. Bell, and Ivan Hosek, Ford Motor Co., Cincinnati

Automatic Techniques in Banking / B. W. Taunton, Asst. Comptroller, First National Bank of Boston

High-Speed Bank Automation / Warren Price, Computer Department, General Electric Co., Phoenix, Arizona.

Data Processing — Its Role in Administration / J. D. Gallagher, Manager of Planning & Development, Sylvania Electric Products, Inc., Camillus, New York

Automation in Railroading / V. E. McCoy, Chief Purchasing Officer, Chicago, Milwaukee, St. Paul and Pacific Railroads Co., Chicago, Ill.
Mail-Flo System Speeds the Mail / S. C. Skeels, Office of Research and Engineering, U.S. Post Office Dept., Washington, D.C.
Mechanization of the Job Shop / W. Willetts, Western Electric Co., Inc., North Andover, Mass.
Data Gathering and Continuous Chemical Processing / P. D. Schnelle, Engineering Research Laboratory, E. I. DuPont de Nemours & Co., Inc., Wilmington, Del.
Use of Data Logging in Chemical Processing / G. P. Russell, Monsanto Chemical Co., Nitro, West Virginia, and T. J. Shuff, Monsanto Chemical Co., St. Louis, Mo.
An Optimizing Control for the Processing Industries / D. A. Burt, New Products Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

The 1958 International Systems Meeting

October 13, 14, 15, 1958

Scheduled at Pittsburgh, Pa., moved to Buffalo, N.Y.

Appraisal of British and European Business Systems / Geoffrey J. Mills, Deputy Chief Controller, J. Lyons & Co., Ltd., London, Eng.
Industrial Management & Systems / J. E. Angle, Vice President, Industrial Engineering, United States Steel Corp.
Parkinson's Law / C. Northcote Parkinson, Raffles Professor of History, University of Malaya, Singapore
Appraisal of Today's Business Systems — Asian Viewpoint / T. Yoshitami Arai, representing the Japan Productivity Center in the International Cooperation Administration, Washington, D.C.
Communications Trends / Lt. General James D. O'Connell, Chief Signal Officer, Dept. of the Army, Washington, D.C.
The Operating Characteristics of the Highly Automatic Factory / James R. Bright, Assoc. Prof. of Business Administration, Harvard Business School, Cambridge, Mass.
The Development and Operation of an Existing Totally Integrated System / Dr. Robert Rosenkranz, President, Rosenkranz & Schneider, Muenchen, Germany
Engineering and Mathematics in Systems Work / Prof. A. Charnes, Prof. of Applied Math. and Economics, The Technological Inst., Northwestern University
Operating and Maintaining Business Systems / Warren E. Alberts, Vice Pres. Industrial Engineering, United Air Lines
The Challenge of Business Records / A. Meeuwis, Mgr. of the Organization, Administrative, Methods, Services Dept., N. V. Philips Gloeilampenfabrieken, Eindhoven, Nederlands
The Human Sciences in Systems / Dr. Robert K. Burns, Assoc. Dean of the School of Business, Univ. of Chicago
Appraisal of Electronic Data Processing / John Diebold, Pres., John Diebold & Assoc., New York
The Productive Office / Neil Pollock, Mgr. of the Org. and Methods Dept., Stewarts & Lloyds, Ltd., Birmingham, Eng.
Computer Trends in Systems Work / Dr. Alan J. Perlis, Carnegie Inst. of Technology, Pittsburgh, Pa.

Collaboration with Research Centers in Systems Studies / Dr. J. Douglas Carroll, Jr., Study Director, Chicago Area Transportation Study, Chicago

Operations Research in Systems Work / Dr. Herbert P. Galliher, Operations Research Project, Mass. Inst. of Techn., Cambridge, Mass.

Communications in the Jet Age / Andre G. Clavier, Vice Pres., IT&T Laboratories, Div. of International Tel. and Tel. Corp., Nutley, N.J.

Approach, Analysis, and Design of a System / Dr. A. V. Feigenbaum, Mgr. Quality Control Service, General Electric Co., New York

What is Systems Work? / Neil Pollock, Mgr. Office & Methods Dept., Stewarts & Lloyds Ltd., Birmingham, Eng.

Tools of Systems Work / George E. Garnsey, Mgr., Systems & Procedures Dept., General Tire & Rubber Co., Akron, Ohio

Records & Correspondence Management / Miss M. Sheppard, Vice Pres., Emmett Leahy Co., Washington, D.C.

Making a Systems Survey / Bruce Smyth, Asst. Vice Pres., Federal Reserve Bank of Chicago, Chicago

Tools of Systems Work / William C. Gill, Office Mgr., Tulsa Div., Douglas Aircraft, Tulsa, Okla.

Methods — Work Measurement / Miss A. Loeber, Hall of Records, Los Angeles County, Los Angeles

Analyzing the Organization / J. G. Nagro, Mgr. Budget Control, The M. W. Kellogg Co., New York

Electronic Systems / R. C. Head, Data Processing Supt., America Fore Insurance Group, San Francisco

Selling Systems & Systems Work / A. Y. Davis, Mgr., Systems Dept., Charles Pfizer & Co., Brooklyn, N.Y.

Forms Control & Design / Cleo Bateman, Vice Pres. in Charge of Operations, Ross-Martin Co., Tulsa, Okla.

Forms Control & Design / Gibbs Myers, Mgr. Systems & Procedures, Kearfott Co., Inc., Little Falls, N.J.

CALENDAR OF COMING EVENTS

May 5-6: Lnterdisciplinary Conference on Self-Organizing Systems, Museum of Science and Industry, Chicago, Ill.

May 6-8: GUIDE Meeting, Pocono Manor, Mount Pocono, Pa.

May 6-8: 1959 Electronic Components Conference, "New Concepts for the Space Age," Benjamin Franklin Hotel, Philadelphia, Pa.

May 11-13: Joint Conference on Automatic Techniques, Pick-Congress Hotel, Chicago, Ill.

May 14-15: Fourth Annual Electronic Data Processing Conference, University of Alabama, University, Ala.

May 14-15: Operations Research Society of America National Meeting, Shoreham Hotel, Washington, D.C.

June 13-23: First International Conference on Information Processing (ICIP) UNESCO House, Paris, France.

June 22-25: British Computer Society 1st Annual Conference, Cambridge, England.

June 24-26: National Machine Accountants Association Conference, Chase-Park Plaza Hotels, St. Louis, Mo.

July 30-31: Denver Research Institute 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colorado.

August 7-8: Northwest Computing Association Conference, University of Washington, Seattle, Wash.

August 18-21: SHARE, 13th Meeting, Olympic Hotel, Seattle, Wash.

Sept. 1-3: Association for Computing Machinery Annual Meeting, Mass. Inst. of Technology, Cambridge, Mass.

Nov. 4-6: National Automatic Control Conference, Sheraton Hotel, Dallas, Texas.

PREDICTING MACHINE

J. Anthony Laguna

Mount Vernon, N.Y.

SEATED behind his huge desk in the enormous ebony-striped chair, the old man seemed like a benevolent caliph. He was smiling gently as his gnarled hands fingered his flowing, white beard. "So you wish to look into the future?" he asked reflectively.

Peter Rodney nodded briskly. He sat erectly opposite the old man — tall, thirtyish, and wearing an impeccably tailored pinstriped suit. He looked the suave, international diplomat all the way from his well-groomed red hair to his glistening, black shoes.

"The U.N. would give a lot to know what the future holds for mankind," he told the old man in a firm, cordial tone. "The world's future is so uncertain right now. Nuclear bombs, radiation exposure threatening humanity, space missiles, depletion of natural resources, — America having its share of trouble — delinquency, automobile deaths, desegregation, skepticism, crime, rock 'n roll."

"Rock 'n roll?" The old man frowned.

"Musical mayhem," Rodney said, grinning. "A joke. So what the future holds — what the world will be like in, say, 2200 — could ease people's minds."

"Or terrify them." The old man looked grave. "When I invented my machine, I thought it would bring people happiness. But it hasn't done that at all. So I've decided to destroy it."

"Destroy— " Rodney stared at the old man, his eyes narrowing.

"The future isn't always what we'd like it to be. To achieve anything usually calls for personal sacrifice of some sort. The future made this apparent. So people went away unhappy."

"But this is different," Rodney said coolly. "It's not my future I want to learn about, but mankind's. Respect for the U.N. is waning. The organization needs something to reawaken belief—rekindle faith—in its abilities. If the U.N. could tell people what the future holds . . ."

"I agree with the consensus," the old man said thoughtfully. "Entirely too much talk today. But telling humanity what's in the future isn't doing anything about the present. No"—and he sighed regretfully—"the machine shall be dismantled."

"I'll pay you handsomely."

"Sorry. My mind's made up."

Rodney mentally stalked through corridors in the labyrinthine maze of his brain, opening doors on dark rooms. Then blinding light flooded him. He leaned back, face impassive, his fingers interlocked. Only his nerves were taut, tingling with the scheme his mind had formulated. He put on a mask of tolerant amusement.

"I thought so," he said, his tone a mixture of feigned scorn and indulgence.

The old man frowned. "I don't understand . . ."

Rodney shrugged, assumed a pose of indifference. He was the tactician now, the adroit diplomat. Nonchalantly, he studied his nails. "It's obvious you've been pulling my leg. Your machine is nothing but a hoax." His gaze locked with the old man's. "I don't believe you have—ever had—a machine to reveal the future."

The old man's eyes hardened. "Very well, Mr. Rodney. You want me to convince you. But you may regret it."

"I'll take that chance," Rodney said, and leaned forward eagerly. "May I see the machine?"

Rodney followed the old man to a door which automatically swung open as they approached and he stepped into a low-ceilinged bare room. A box-like machine squatted in the center of a tiled floor. Innumerable push-buttons protruded from the keyboard like colored warts. Beside it stood a typewriter. Rodney thought the machine awfully small to be capable of such fantastic powers.

"Sit down," the old man ordered, and two stools instantaneously popped up from the floor like mushrooms. Rodney sat down, faced the machine.

"This is only the control unit," the old man said. "The computer—my Intelligence Machine—is in the cellar. It is water-cooled. It runs red-hot as a result of electron bombardment."

"I'm not a scientist," Rodney said, "but I'd like to hear about the machine."

The old man jabbed the keyboard with his finger. Jeweled lights burst on. A loud humming filled the room, vibrated the floor. "The computer is now on. Takes a while to warm up."

Rodney listened as the old man explained about the Intelligence Machine, a machine whose brain was capable of evolution by controlled mutation, so that, speeded up to break the Euclidean time barrier, the brain could hurtle through space and time to a distant epoch. Its televisor eyes, its external recorder-translator, its spidery, sensitive ganglia would receive impressions and put them in memory to be retrieved when the brain was brought back to its own era.

"The machine's ready," the old man said, as a needle slowly oscillated in a panel meter. "What year shall we send the brain to?"

"Really doesn't matter," Rodney replied. "How about 2200 A.D.?"

The old man pushed several buttons. He sat back. "This will take a few minutes," he told Rodney. "When the brain returns, the syncomatic typewriter over there will print the information stored in its memory."

"This information — is it random information?"

The old man shook his head. "No. All stimuli and other pieces of information have been assigned a numerical value. Governments have the values n sub i; societies the values q sub i; philosophies the values p sub i; and so forth. The memory has a storage capacity in excess of one hundred thousand pages. Because my machine has the ability to make decisions — that is, can select information it deems pertinent and reject all other — we will only obtain what its brain considers most important."

"I see," Rodney said, wetting his lips with anticipation.

A bell deep within the control unit rang. The humming abruptly ceased. A light marked PRINT flashed in the keyboard. "We're ready," the old man announced quietly, and flicked a switch.

The syncomatic typewriter began to type. Clackety, clackety, clack. Rodney stiffened. His brow was sweat-beaded, even though the room was cool. The typing stopped. Rodney threw a quick glance at the old man and hurried to the printer. He peered at the typed words:

"One world under God."

Footsteps came up behind him. "Well?" asked the old man.

Rodney stared at the words a long moment. He turned to the old man, his face stony. "Personally, I'm very pleased. But my report to the U.N. will be modified somewhat. 'Entire world ruled by dictator' should convey the thought."

The old man compressed his lips, as if nauseated.

"Diplomats are hard-pressed enough as it is," Rodney went on, his smile brittle. "If nations were to hear that peace is a future certainty, diplomats might as well take in laundry for a living."

The old man remained silent.

"I know what you're thinking," Rodney said, somewhat apologetically. "My announcement will increase suspicion, hatred, and arms buildup in the world. But as the future is to be 'one world under God,' my report to the U.N. will cause no real harm. I'll tell the press that your machine revealed this terrifying prediction. You'll be a national hero. I'll get credit for having persuaded you to operate the machine. We'll both reap something from this revelation. We've got to think of our careers, you know."

Contempt flickered across the old man's face.

"Well, I thank you," Rodney said, and pumped the old man's hand energetically. "You've been most cooperative."

He left.

The old man went to the control panel. His expression was puzzled. "With human nature the way it is," he mused, aloud, "how can the world possibly achieve the miraculous utopia predicted?"

He plugged a microphone into the program-translator connected to the storage circuit. "Explain why 2200 is so peaceful," he instructed the machine.

The unit hummed, relays clicked. The old man closed the distance between himself and the printer. The typewriter keys drummed sharply and stopped. As he read the bold, black type, he uttered a cry:

"Homo Sapiens extinct."

SURVEY OF RECENT ARTICLES

We publish here a survey of articles related to computers and data processors, and their applications and implications, occurring in certain magazines. We seek to cover at least the following magazines, beginning with issues dated January 1, 1959, or later:

- Automatic Control
- Automation
- Automation and Automatic Equipment News (British)
- Business Week
- Control Engineering
- Datamation
- Electronic Design
- Electronics
- Harvard Business Review
- Industrial Research
- Instruments and Control Systems
- ISA Journal
- Proceedings of the IRE
- Management Science
- The Office
- Scientific American

It is not easy to look into more than fifteen magazines each month, and make a search; the purpose of this type of reference information is to help anybody interested in computers find articles of particular relation to this field in these magazines.

For each article, we shall publish: the title of the article / the name of the author(s) / the magazine and issue where it appears / the publisher's name and address / two or three sentences telling what the article is about.

Computer Runs Refinery Unit / Business Week, March 7, 1959 / McGraw-Hill, 330 West 42 St., New York 18, N.Y.

A computer operates and controls a complex petroleum processing system, and promises to eventually lead to wide acceptance of the computer by the petroleum industry. Among the many advantages, the most significant one is the computer's ability to adjust the process continually, to make output optimum according to product or economic standards.

Stating a Problem / J. M. Kibbee / Machine Accounting and Data Processing, vol. 1, no. 2, Jan.-Feb., 1959, p 5 / Gille Associates, Inc., 956 Maccabees Building, Detroit 2, Mich.

Changing a procedure, a control panel or a computer program is expensive and time consuming. Stating the problem correctly — nineteen questions that should be considered — can help prevent the need to alter an original process.

Digital Memory System Keeps Circuits Simple / T. C. Chen, and O. B. Stram, Burroughs Corp. Research Center,

Paoli, Pa. / Electronics, vol. 32, no. 11, Mar. 13, 1959, p 130 / McGraw-Hill, 330 West 42 St., New York 36, N.Y.

A magnetic memory, which uses a flat-surfaced aluminum disk capable of storing from 50 to 100 words, is now used in small, low-cost digital computers. A description of its performance is given.

Forming Handwritten-Like Digits on CRT Display / R. L. White, Chief Applications Engineer, Semiconductor Div., Hoffman Electronics Corp. / Electronics, vol. 32, no. 11, Mar. 13, 1959, p 138 / McGraw-Hill, 330 West 42 St., New York 36, N.Y.

A readable and reliable digital display, which is designed to use small cathode-ray tube readout elements. These elements provide good viewing characteristics, while also giving comparatively trouble-free operation.

Significant Digit Computer Arithmetic / N. Metropolis and R. L. Ashenhurst, Institute for Computer Research, University of Chicago / IRE Transactions on Electronic Computers, vol. EC-7, no. 4, Dec., 1958, p 265 / IRE, Inc., 1 East 79 St., New York 21, N.Y.

Error analysis is often difficult with the floating point arithmetic of the computer. An alternative system is described, which suggests a means of effectively analyzing floating point calculations, and which also possesses certain equipment advantages.

On the Minimum Logical Complexity Required for a General Purpose Computer / S. P. Frankel, Consultant, Logical Design, Long Beach, Calif. / IRE Transactions on Electronic Computers, vol. EC-7, no. 4, Dec., 1958, p 282 / IRE Inc., 1 East 79 St., New York 21, N.Y.

"The term *general purpose computer* (gpc) has been applied to a variety of digital computing instruments." A definition is given for this term, and a "gpc" with minimum complexity is presented in functional and logical design.

On the Job, Automatic Tools Prove Virtuosos / Business Week, March 14, 1959, p 77 / McGraw-Hill, 330 West 42 St., New York 18, N.Y.

A system developed at MIT employs a computer to automatically control the design and construction of tools, airplane parts, and various mechanisms. The Automatically Programmed tools system (APT) blends the diverse fields of electronics, metal cutting, electrical engineering, and computer technology, to perform in a few minutes operations which normally take a few weeks.

Numerically controlled machine tools save 50% to 90% on production costs, and are revolutionizing short-run metal-working production. A computer translates drawings into parts, through an automatic program, and also produces a punched tape that goes to the machine director.

Digital Telemetering Chosen for Remote Control / J. F. Conneran, Instrument Section Head, Arabian American Oil Co., New York, New York / I. S. A. Journal, vol. 6, no. 3, Mar., 1959, p 44 / Instrument Society of America, 313 Sixth Ave., Pittsburgh, Pa.

Digital techniques remotely control the operation of a Saudi Arabian oil pumping station; also, how they work, why they were chosen over other methods, and future performance expectancies.

Selling Brainpower's Byproducts / Business Week, Mar. 14, 1959, p 84 / McGraw-Hill, 330 West 42 St., New York 18, N.Y.

By expanding its data processing facilities, North American Aviation intends to profit from ideas "spawned by its technical brainpower." It has developed an automatic checkout system which checks computers quickly, thus making them available sooner. Instead of licensing out discoveries made in the Autonetics Division, the company is computing in the computer field with the bigger producers of computers.

Digital Recorder Holds Data After Shock / C. P. Hedges, Curtiss-Wright Corp., Santa Barbara, Calif. / Electronics, vol. 32, no. 12, March 20, 1959, p 60 / McGraw-Hill, 330 West 42 St., New York 36, N.Y.

Data which is recorded before an impact, is retained by magnetic cores. For example, a recorder memorizes the instantaneous magnitude in the variations of parameters, and this data is stored in ferrite cores, which hold the data even after strong shock impacts.

Electronic Computers — Slave or Master? / C. A. Swanson, Manager, Office Methods Planning Dept., Proctor & Gamble Co. / Journal of Machine Accounting, vol. 10, no. 3, Mar., 1959, p 16 / National Machine Accountants Assn., 208 South Main St., Paris, Illinois

After an investigation of a wide range of electronic computers and related equipment, the author answers, "slave." Both sides of the question are presented.

Multiloop Cascade Circuits Control British Sugar Refinery / E. R. Eglington, Evershed and Vignoles, London / Control Engineering, vol. 6, no. 2, Feb., '59, p 79 / McGraw-Hill, 330 West 42 St., New York

All-electronic control is employed by a European sugar factory for the operation of a continuous diffuser plant. Three-term controllers and simple force-balance computers provide integrated forward and backward cascade control over the entire process.

Computers Lift Transistor Sales / Electronics, vol. 32, no. 10, Mar. 6, 1959, p 29 / McGraw-Hill, 330 West 42 St., New York 36, N.Y.

The main characteristic common to all of several new computer systems, is that they are solid-state computers. Some are all-transistorized, requiring between 20,000 and 70,000 transistors.

Simulation of Industrial Processes With The Analog Computer / C. W. Worley, Electronic Associates, Inc. / Automatic Control, vol. 10, no. 1, Jan., '59, p 44 / Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.

Use of a computer as an engineering tool, providing a process engineer with a practical way of investigating performance of industrial processes. Typical problems and computer answers.

How to Plan Computer Control / M. Phister, Jr., Director of Engineering, Thompson Ramo Wooldridge Products Co. / I S A Journal, vol. 6, no. 1, Jan., '59, p 51 / Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

A plan to evaluate, develop, and install closed-loop computer control systems, which is now being used in continuous or batch chemical and petroleum processes. Reasons for the implementation of computer control; the developing and installing of such a system.

Unregulated Power Supplies for Digital Computers / L. M. Hollingsworth, and J. H. Hayden, Rectifier Department, General Electric Co. / Automatic Control, vol. 10, no. 1, Jan., '59, p 52 / Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.

In a multi-purpose computer, where it is necessary to the steady-state average load level on the supply, the "no load to full load" regulation of an unregulated supply is important. Methods of regulating "no load to full load" voltage are considered.

The Analogue Computer / G. A. Cass / Automation & Automatic Equipment News, vol. 4, no. 7, March, 1959, p 1023 / A. & A. E. N., 9 Gough Square, Fleet St., London, E. C. 4.

Describes analog and digital computers, and compares their relative merits. Also discusses input and output problems, time-dimensions of operation, applications of both kinds of computers.

A High-Speed Electronic Printer For Digital Computer Output / W. S. Grant, Radiation, Inc. / PB 151331 OTS, U.S. Dept. of Commerce, Washington 25, D.C.

This 111 page report describes a high-speed electronic printer, which can write twelve characters in parallel across a five-inch chart, at a speed of 2160 characters per second. Each character unit has the circuitry to produce any decimal digit, a minus sign, and a decimal point. With the use of an analog-to-digital converter in the input of the printer, it could operate in conjunction with analog computers; the amount of printable characters available is considered unlimited.

A Survey of British Digital Computers

(Part 3—Concluding Part)

Joseph L. F. De Kerf
Research Laboratories
Gevaert Photo-Producten N.V.
Mortsel, Belgium

(Continued from the April issue, p. 36)

— Stantec-Zebra

Operation mode: serial. Number base: binary. Word length: 32 bits plus sign. Program code: alphanumeric, interpreted by input programs. It incorporates a programming philosophy evolved by the Netherlands P.T.T. Instructions: 2 address, 1 + next address or 1 + order modification type (1 word).

Main store: magnetic drum. Capacity: 8,192 words. Speed: 6,000 rpm. Access time: 5 ms average. Switching between tracks is transistorized. Special tracks are provided as immediate access computing store. The capacity is 15 words. Connection of magnetic tape units, over ferrite buffer stores, is optional. The tape units are constructed by the Bell Telephone Mfg. Co. (Antwerp, Belgium).

Input: punched tape (200 char. per sec). Output: punched tape (25 or 50 char. per sec) and electric typewriter (7 char. per sec). Connection of punched card equipment (200 and 100 cards per min for input and output respectively) and high speed printer (Samastronic: 300 lines of 140 char. per min) is optional.

Operation speeds: 0.624 ms for addition and subtraction (including instruction), 11 ms for multiplication and 35 ms for division (both optimum).

Power consumption: 5 kVA. Room accommodation: 200 sq. ft and up. Price of the standard machine: £ 25,000.

WHARF ENGINEERING LABORATORIES, The Wharf, Fenny Compton, Warwickshire.

Wharf Engineering Laboratories was formed by the late S. J. Booth, in 1948. Its present director is K.H.V. Booth. It has been associated with the work of Birkbeck College Computational Laboratory (University of London) and its products include magnetic storage drums, paper tape readers, tape punches and pulse transformers. The U.S. representative is IMTRA Corporation, Boston, Mass.

The laboratories have produced a prototype computer MAC, based on the APE(X)C designed by A. D. Booth, at Birkbeck College. An improved version, the M2 computer, was developed. Five M2 computers, destinated for universities and other mathematical laboratories, are at present in existence: three have been tested and two are completed.

— M2

Operation mode: serial. Internal number system: binary. Word length: 32 bits (including sign digit). Instructions: 1+1 address type (1 word).

Store: magnetic drum. Capacity: 8,192 words. Speed: 3,000 rpm. Access time: 64 words have immediate access and the mean access time for the remaining words is 10 ms.

Input/output: 5 hole paper tape. Speed: 75 char. per sec both.

Operation speeds (memory access time not included): 0.5 ms for addition and subtraction, 10 ms (mean) and 20 ms (maximum) for multiplication and division.

Power consumption: 1.5 kVA. Floor area occupied: 6 sq. ft. Price: estimated to be £ 8,000. The computer is not marketed for the moment.

Remarks

We have described eighteen machines, constructed by ten manufacturers. Fifteen are realizations, while three (Hollerith 1400, Emidec 2400 and Metrovick 1010) are in construction. Sixteen machines have internally stored program and two (Hollerith 555 and Powers-Samas PCC) are controlled by plugboards. The latter were added for their magnetic drum storage.

It is not the attempt to give a complete comparison between these machines. Following remarks are however striking:

— Most computers are serial in operation mode. Three machines (Hollerith 555, Hollerith 1400 and Powers-Samas PCC) are serial parallel. One computer (Mercury) is serial in operation and parallel in storage. Three (Emidec 1100, Emidec 2400 and Metrovick 1010) are parallel, but only one (Emidec 1100) has been completed so far.

— The internal number base of most computers is binary. Three machines (Hollerith 555, Hollerith 1400 and Powers-Samas PCC) are binary decimal. The mean word length is 38 bits. One computer (Perseus) has an extra long word length of 72 bits. One computer (Emidec 2400) has variable word length for alphanumeric data.

— Seven computers have 1 address instructions, eight have 2 or 1+1 address instructions and three have 3 or 2+1 address instructions. Twelve machines are sequence controlled. Four computers have built-in floating arithmetic. Two machines (Hollerith 555 and Leo II) have automatic root extraction. For two computers (Mercury and Metrovick 950), division is by subroutine. Sterling processing is automatic for six machines.

— Six computers are transistorized. Six computers use delay lines, five computers use magnetic cores and one computer (Emidec 2400) uses diode-capacitors as quick access store. Sixteen machines have magnetic drums and two have magnetic cores for their main store. Typical capacities of the drums are 4,096 and 8,192 words. Most have a mean access time of 10 ms. One computer (Elliott 405) uses a magnetic disc store and one computer (Metrovick 1010) uses an extra drum with high capacity (60,000 words) as random access store.

— Twelve computers have an optional backing store by connection of magnetic tape or film units. A maximum of 16 tapes or films is typical. Four computers use Decca twin tape units, three use ElectroData tape units, two use EMI tape units, one uses Bell tape units and two use film units, designed at the Manchester University. A remarkable read/write speed is that of the EMI units: 20,000 char. per sec.

— Input/output by punched cards, punched tape, line printers and typewriters is used throughout. Remarkable card input speeds are 400 cards per min (Elliott) and 600 cards per min (Hollerith). Remarkable punched tape input speeds are 500 char. per sec (Elliott), 850 char. per sec (English Electric Co.) and 1,000 char. per sec (Elliott and Metropolitan-Vickers). A remarkable punched tape output is 300 char. per sec (Creed). Several machines have a line printer output with a speed of 300 lines per min (Samastronic). One machine (Emidec 2400) will have an off-line xerographic printer output with a speed of 3,000 lines per min.

— Operation speeds are relatively low. Computers with a multiplication speed of some ms are Hollerith 1400, Elliott 402, Elliott 405, Deuce, Pegasus and Leo II. Higher speeds are those of Emidec 1100, Emidec 2400, Mercury and Metrovick 1010, but only two of them (Mercury and Emidec 1100) have been completed.

— Prices are relatively low when compared with the capacities. Efforts of British manufacturers are directed to the realization of medium scale computers with optional expansion possibilities to data processing systems. This is justified as the need of the European market for large scale computers is limited for the moment. There is however a lack of cheap small scale computers. Internally stored program computers which, more or less, satisfy these requirements are Elliott 402E and Stantec-Zebra (the standard machine). Cheaper computers are Metrovick 950 and Elliott 802, but Metrovick 950 is slow and the store capacity of Elliott 802 is too small. It is hoped British manufacturers of computers will consider this in the future.

APPENDIX

The following is a summary of the number of British computers shipped and on order:

Manufacturer	Model	Quantity Shipped Unless Otherwise Noted
British Tabulating Machine Co.	555	15
" " " "	1201 & Hec 1202	50
" " " "	1400	*
Elliott Bros.	402, 405, & 802	45**
English Electric Co., Ltd.	DEUCE	20
Ferranti Electric	Ferranti Pegasus Computer	20
" "	Ferranti Mark I Computer	1
" "	Ferranti Mercury	16
Leo Computers, Ltd.	LEO II	7
Metropolitan-Vickers	Metrovick 950	3†
Powers-Samas Accounting Mach., Ltd.	P.C.C. Calculator	35
Standard Telephones & Cables, Ltd.	Stantec-Zebra	15
Wharf Engineering Labs.	M2	5‡
	Total	232

* To be completed in near future.

** Approximately.

†Operating.

‡On order.

BOOKS and OTHER PUBLICATIONS

WE PUBLISH HERE citations and brief reviews of books, articles, papers, and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation.**

New Computers — A Report From the Manufacturers / Association for Computing Machinery, Los Angeles Chapter / Assoc. for Computing Machinery, 2 East 63 St., New Yoik 21, N.Y. / 1957, photo offset, 133 pp., cost ?

The report of this symposium, which took place in March, 1957, in Los Angeles, Calif., includes nine papers as follows: Magnetic Tape File Processing with the NCR 304 (Natl Cash Register Co.); The Cardatron and the Datafile in the Datatron System (Burroughs Corp.); A New Large-Scale Data Handling System, DATAmatic 1000; BIZMAC II Computer, Characteristics and Applications (RCA); The X308 Computer (RemRand Univac); The IBM 709 Computer! Design Objectives for the IBM Stretch Computer; Philco S-2000 Transistorized Large-Scale Data Processing System; The Alwac Corporation Model 800 Computer.

Phister, Montgomery, Jr. / Logical Design of Digital Computers / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1958, printed. 408 pp., $10.50.

The purpose of this book is to instruct in "computer logic, the art and science of designing . . . digital systems." The book describes techniques rather than machines, and is based on the belief that Boolean algebra has become necessarily one of the most useful tools of the designer of digital computer circuits.

The chapters include: digital computers and their design; circuit components and binary numbers; Boolean algebra; the simplification of Boolean functions; memory element input equations; the derivation of application equations; digital computer memories; input-output equipment; the arithmetic unit; error-free computer operation; the control unit; completing computer design; miscellaneous practical matters.

This is an interesting, useful, and valuable book.

Ragazzini, John R., and Gene F. Franklin / Sampled-Data Control Systems / McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y. / 1958, printed, 331 pp., $9.50.

This text gathers under one cover important topics concerning the analysis and design of feedback and control systems which have previously been treated in various papers and reports. The authors also include recent research data and new, unpublished material concerned with discrete systems. The text material is largely theoretical, being specifically directed to the design of sampled-data control systems where "such specifications as stability, response and output ripple are of importance," but it also contains much information having general applications, such as data-reconstruction theory and the theory of sampled random functions. A list of references appears at the end of the book.

Gass, Saul I. / Linear Programming: Methods and Applications / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1958, printed, 223 pp., $6.50.

The author prepared much of the material of this book for an introductory course in linear programming which he taught. He seeks to bring together the theoretical, computational and applied aspects of linear programming insofar as practical and possible. He treats the revised simplex method, digital computer codes, linear programing applications and problems. Also, he includes a bibliography of linear programming applications.

Millman, Jacob / Vacuum-Tube and Semiconductor Electronics / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1958, printed, 644 pp., $10.00.

Professor Millman has designed his book as a text for a first course in electronics. He first attempts to present simultaneously "a clear, consistent picture of the internal physical behavior and . . . the external circuit characteristics of vacuum, gaseous and semiconductor devices." Secondly, he interweaves a treatment of transistors with vacuum-tube electronics. The material considers in detail concepts of load line, bias curves, input and output impedance, effects of feedback, and many other methods of analysis and characteristics common to such devices and circuits. It includes problems intended to help the student try out his learning — to make him aware of the type of problems he will meet and the possible ways of solving those problems.

Recent Advances in the Engineering Sciences — Their Impact on Engineering Education / Proceedings of Conference on Science and Technology for Deans of Engineering / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1958, printed, 257 pp., $4.75.

This conference was held in September, 1957, at Purdue University, Lafayette, Ind. Papers were presented on these topics: Automation and Automatic Control; Operations Research and Systems

Engineering; Administrative Problems in Engineering; Thermodynamics; Mass, Momentum, and Heat Transfer; Nuclear Engineering; Solid State Physics and Engineering Materials; Computer Development and Applications. Each contributor is an authority in his field and is familiar with engineering education.

Cunningham, W. J. / Introduction to Nonlinear Analysis / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1958, printed, 349 pp., $9.50.

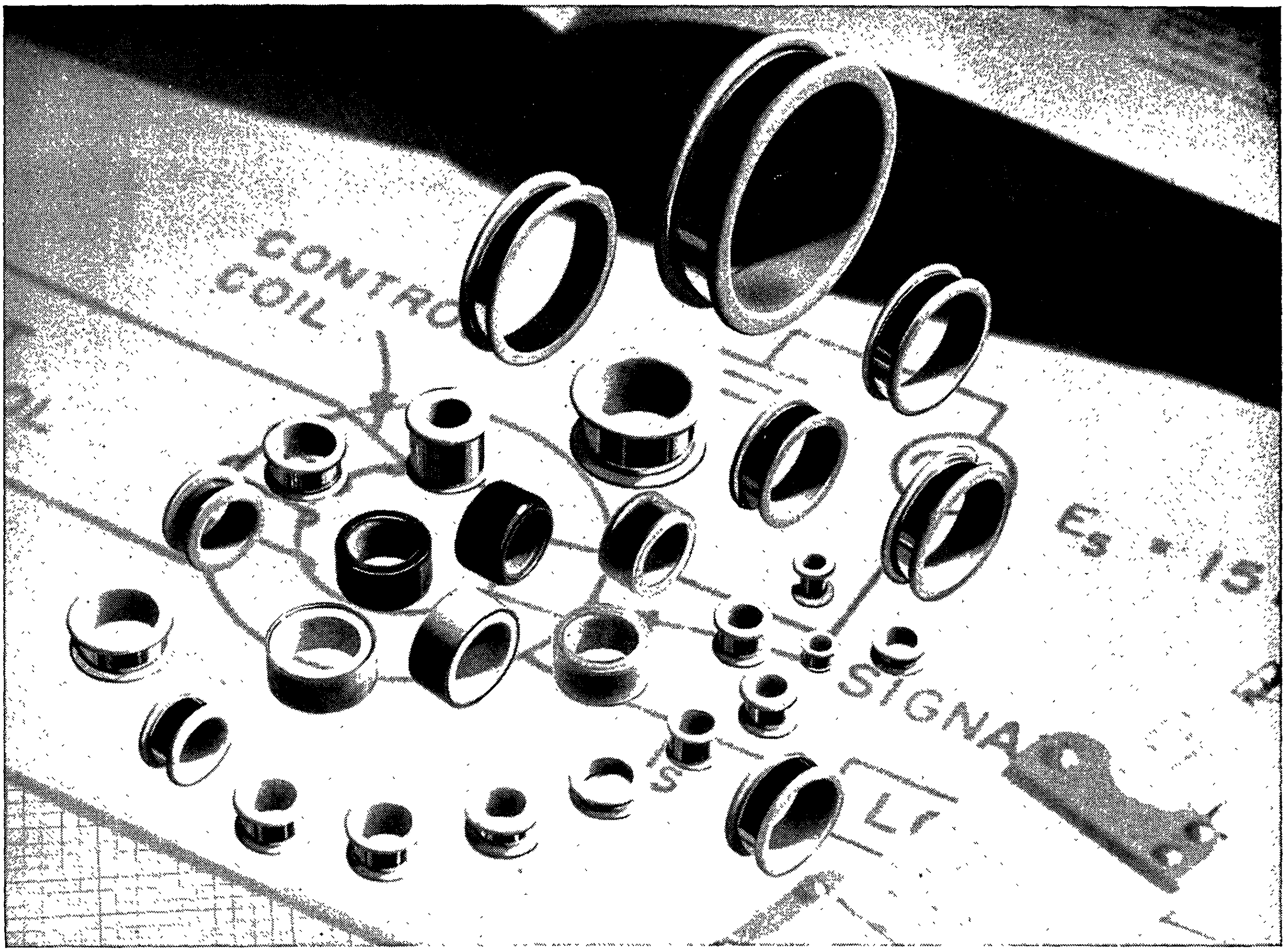
This text intends to provide the scientist and the engineer with methods for finding solutions of nonlinear differential equations having a single independent variable. The authors treat numerical, graphical and analytical methods, and they provide ample illustration of each. The text seeks to present coherently all these methods "from the viewpoint of an engineer who wants to use the mathematics as a tool for attacking the problems which confront him." Each chapter includes exercises. The reader needs a basic knowledge of electrical circuits, mechanical systems, and linear differential equations if he is to benefit from this text.

Riley, Vera, and Saul I. Gauss / Linear Programming and Associated Techniques / Operations Research Office, The Johns Hopkins University, Chevy Chase, Md. / 1958, printed, 613 pp., $6.00.

This is a comprehensive bibliography on linear, nonlinear and dynamic programming and divides the references into four sections: introductory, containing basic subject references; general linear programming theory; applications of linear programming; nonlinear and dynamic programming. Each reference is described in detail. A useful appendix gives complete data on the author or issuing agency of the pertinent reference material.

ADVERTISING INDEX

Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.



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Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

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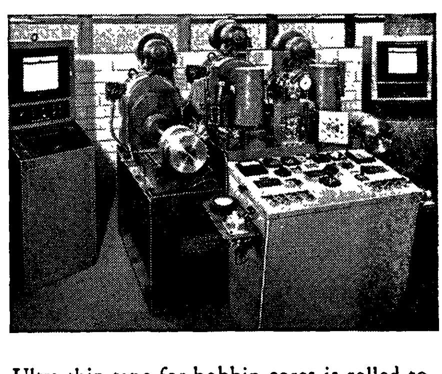

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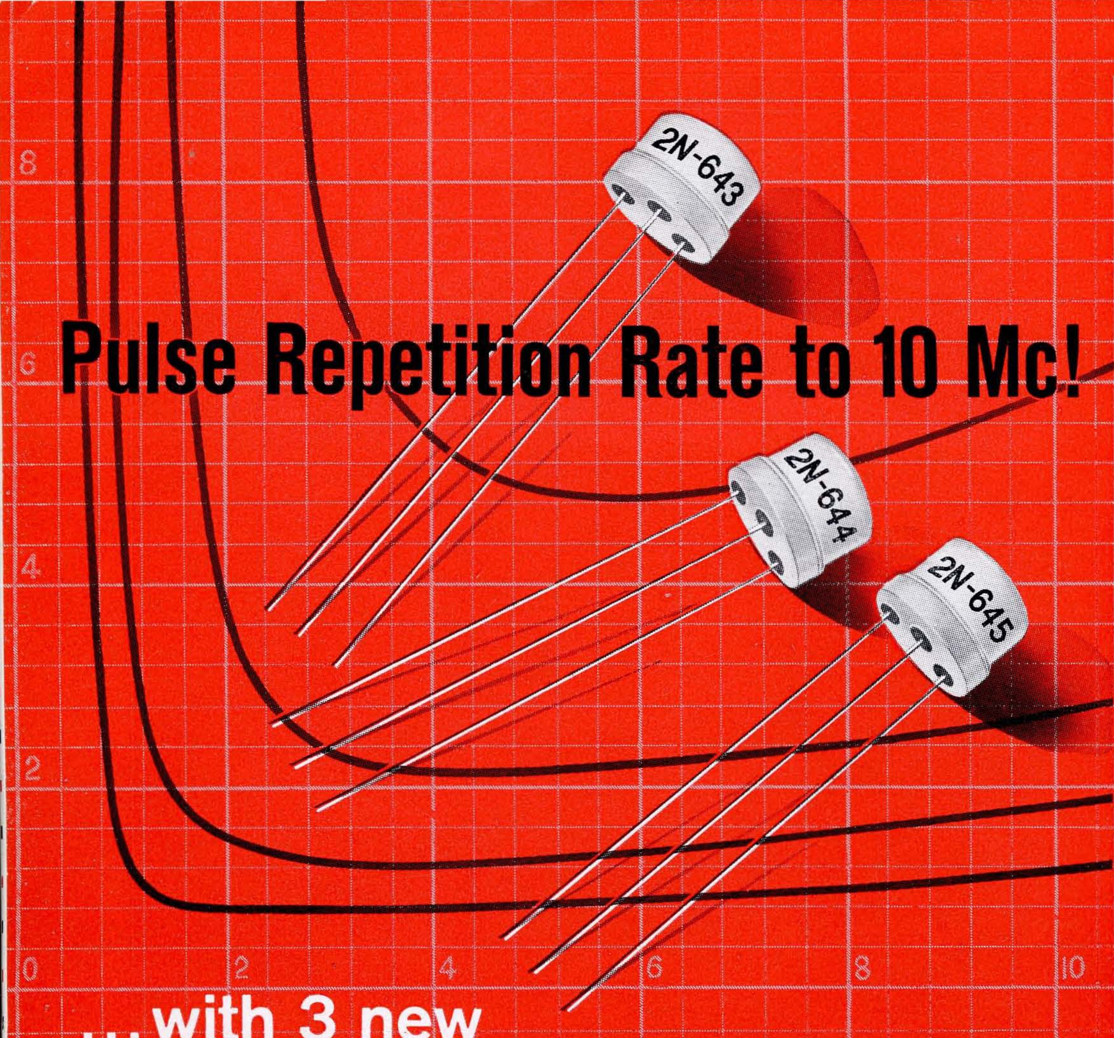
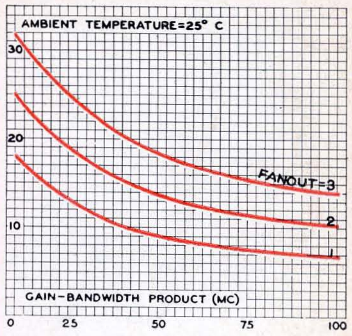
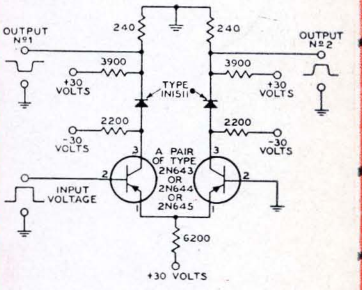


Pulse Repetition Rate to 10 Mc!



Curves illustrate typical delay time per stage vs. gain-bandwidth product and fanout for the switching circuit shown below.



NOTE: ALL RESISTANCE VALUES ARE IN OHMS.

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Minimum collector** breakdown volts	30	30	30
Minimum DC current transfer ratio*	20	20	20
Maximum collector capacitance µµf	5	5	5

*Collector Volts = -7, collector ma = -5
**Collector Current = 100 µa

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