formula translation; in particular, Rutishauser's and Bauer and Samelson's work is briefly discussed, with very little reference to relevant developments in the U. S. A. This is followed by a very general section on language unification. As mentioned earlier, starting with Chapter 3 the author has built up and used an algorithmic language based on ALGOL. Chapter 11 now gives a precise definition and summary of ALGOL-60, using Backus' notation. The final Chapter 12 is entitled "parallel programming" and gives a survey of various aspects of this field, including such topics as input/output buffering and program interrupts, and including a fairly representative citation of basic references.

Many programming examples are used in every chapter to elucidate the discussion. Each example stresses the parallelism of the language presentation and consists of a general problem statement, a detailed flow chart, a full Z-22 symbolic program as well as an ALGOL program. The examples are taken in part from numerical analysis, but there are also a large number of problems from various areas of business data processing.

The book is written in a lucid style and makes very good reading. The overall presentation shows the commitment of the German computing community to ALGOL. At the same time, a significant feature of the book is its complete lack of material on programming and monitoring systems, the use of tapes or disks, and similar problems of importance to users of large-scale computing systems.

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EDITORIAL NOTE: The first edition, entitled *Einführung in die Programmierung digitaler Rechenautomaten*, was reviewed in *Math. Comp.*, v. 15, 1961, p. 316.

61[Z].—WALTER HOFFMANN, Editor, *Digital Information Processors*, John Wiley & Sons, Inc., New York, 1962, xxi + 740 p., 23 cm. Price $27.00.

This is a most welcome volume to everybody in the computer field who cares to know what happens outside of his own particular area of computer applications. In the words of the editor, "it is addressed primarily to those readers already familiar with computers, and the computing specialists, who, for example, wish to learn about their neighboring areas or about new trends which have not yet become common knowledge".

Each of the 25 contributors had complete freedom as far as the presentation of their subject and the expression of their opinions was concerned. Eight contributions are in German, seven are in English, and each is preceded by English, French, and German summaries.

The first article by Heinz Zemanek on automata and thought processes is a critical study on the nature of automation. He analyzes automata and thought processes from the point of view of one skilled in the automation engineering art. Then he summarizes and critically reviews published work. He goes on to single out the basic processes of reproduction, reduction, and expansion of information and describes the famous "artificial animals". Specific problems such as learning, composing, game-playing, and problem solving by machine are discussed. The paper ends on a philosophical note: "Is there an end to the natural sciences?"

The second article by Ambros P. Speiser on new technical developments is an account of the current work which will pave the way for the second computer generation. While the first generation is conveniently defined as the sum of all computers up to the present time, the present efforts are classified in two areas: (a) perfection of the techniques for the construction of our present computers, (b) increase of the speed and memory capacity of large and small computers. The second stage of development involves many aspects of the physical sciences and is the main topic of this paper. Most of it is devoted to magnetic-core storage, trapped-flux-super-conducting memory kryotrons, disk storage, read-only memories, flying-spot memories, and different output devices.

A paper by R. Tarján deals with logical machines, which are classified according to their problem-solving ability. The main topic is the abstract theory of automata consisting of two-valued decision elements.

T. Erisman presents an article on digital differential analyzers. He describes the demand for such devices and the circuitry required. The historical development is outlined and the main features of "Integromat", "Maddida", "Bendix DDA", and "Trice" are described. The author discusses the advantages and disadvantages as compared with analog and digital computers. In general, in a given time the DDA will produce more accurate results than analog computers. But using the same number of arithmetic units, the analog computer is cheaper in price and analog information has to be converted into digital form before input in the DDA. But it is added that both advantages shrink somewhat since every error in a DDA is of a systematic nature, and that coupling of many integrators reduces speed considerably.

In an article "Interrelations between Computers and Applied Mathematics", Herman Goldstine analyzes the effects that large-scale, electronic computers have had upon applied mathematics. One kind of effect relates to the impact of the new machines on numerical analysis, another shows the opportunity for gaining new insights into areas as yet inaccessible by conventional means. In the first category three kinds of errors are discussed: input errors in the data (empirical or experimental), the truncation error of the discrete step methods, and digital noise, due to finite word length. He concludes with an excursus on Bliss' techniques applied to a system of ordinary differential equations.

F. L. Bauer's and K. Samelson's paper on processing of programming languages by computers describes the way from early "automatic programming" to the modern problem oriented languages: FORTRAN, PACT, AP3, Mercury autocode, ALGOL 58, ALGOL 60, COBOL, and a language proposed by Lyapunov, which is widely used in Russia. A universal metalanguage is predicted to be the next step in this development, as already indicated by Zuse's "Plankalkül" and the General Problem Solver (GPS) of Newell, Shaw and Simon and J. McCarthy's work with LISP.

W. L. van der Poel's article on micro-programming and trickology, shows, by example of the ZEBRA computer, ways to overcome the shortcomings of present day computers in searching lists, block transfer, sorting, etc. Ways are shown to build up macro-instructions from a coding system, where the programmer has immediate access to the micro-programming of the machine. Repeating of an instruction, or the generation of programs in fast registers, not written out beforehand is illustrated ("under-water programming").

R. W. Bemer's paper "The Present Status, Achievement and Trends of Programming for Commercial Data Processing" describes some of the basic elements of programming techniques developed during the last eight years in commercial data-processing problems. Automatic operating systems, tabular languages, input-output control systems, automatic production of automatic programming processors, remote operation of computers through communication links, standardization of techniques, and communication between different computers by common language are trends which are noted in modern programming. Generalizing of programs and program sharing among many users are other important features of programming today.

H. K. Schuff in an article on "problems in commercial data processing" discusses the basic philosophy of automatic data handling. He attempts a systematic classification of these problems by using control circuits, the elements of which represent the places where high densities of data occur.

Y. Bar-Hillel discusses theoretical aspects of the mechanization of literature searching. He distinguishes between data-providing and reference-providing systems. References can be provided in (at least) four stages: accession numbers, citations, abstracts and copies of the selected documents. The idea of shortcircuiting reference-providing by scanning the document collection directly with a high-speed computer is rejected. Automatic indexing and extracting are criticized as either leading to inferior products or as being uneconomical. He shows where an electronic computer might be employed usefully in the library problem and discusses the attempts to establish a general mathematical theory of literature search, which he feels to be failures. He delegates the computer to performing merely the routine operations and wishes to see the human having constant control over the operations.

A rather extensive paper by E. Reifler on machine language translation is divided in two parts. In the historical outline, the worldwide efforts on MT are described. Part two is a review of the fundamental bilingual lexicographic and linguistic problems of multiple grammatical and non-grammatical meaning, and the problems of the automatic identification and translation of potential future, and, therefore, still unrecorded, compound words. It finally demonstrates a sample of MT output from the University of Washington research material.

K. Zuse's paper on the evolution of computer development from mechanics to electronics gives an account of the author's efforts in this field, which date back to the year 1934. The prototypes Z1, Z2, Z3, Z4 which were built by the author during World War II, in Germany, are briefly discussed. The construction was resumed after an involuntary pause of four years, and led to the computers Z22, Z23 and Z31, the two latter ones being fully transistorized. The Z22 computer is described in some detail. An outlook on digital field computers follows, to which the author was led by the study of meteorological problems.

Jan Oblonský's report on computer progress in Czechoslovakia is a description of the self-correcting features of the Czech computer SAPO, which stands for Samočinný Počítač, i.e., automatic computer. SAPO is a five-address machine with error detection through parity checks and re-reading after writing in memory, checking of transfers through parity check, checking of the operations by performing

them in triplicate, checking of the control, checking of input and output units through multiple read and punch features. The correction of errors is affected by entering a micro-program which checks address and instruction parities separately and induces necessary repeat instructions. Failure after one repeat cycle causes the machine to stop and print a diagnostic statement. After four years of successful operation, the author finds that microprogrammed error correction is more economical than simultaneous execution of the same instruction several times.

The second article of the same title by Antonín Svoboda, the chief designer of SAPO, in on the number system of residual classes (SRC). It is an interesting paper on the usefulness of SRC-encoding of numbers in computers and its effects on the arithmetic unit and logical design of a computer. The concept is relatively new, but it can be expected that interesting features, algorithms, and logical designs will emerge from it in the future.

A seven-part paper by Hideo Yamashita and others report on the digital computer development in Japan since 1939. Each part is written by a different author, tracing the development essentially through 1961. M. Goto and Y. Komamya describe the relay computer ETL Mark II (pilot model 1952), H. Takahasi and E. Goto report on the parametron, its principles and its application as a logical element in a computer. The same two authors also discuss memory systems for parametron computers in another article. S. Takahashi and H. Nishino describe the transistorized computer ETL Mark IV which is completed in 1957. Still a relatively slow and small computer (180 kc/sec cycle time, 1 K magnetic drum memory with 1.67 ms average access time), it is the second fully transistorized Japanese computer built. T. Motooka has a paper on magnetic core switching circuits and E. Goto reports on the Esaki diode, or the tunnel diode, as we know it. The seventh paper in this series is by N. Kuroyanagi on a specific high-speed arithmetic system built with an adder, a shifting register, detector, and a selective transmission unit. The purpose is to perform a chain of complicated logical operations of great depth in one step.

The last article is written by the editor of the volume, W. Hoffman. It is a capsule history of automatic computing from the Chinese abacus (1100 B.C.) through the mid-fifties in the U.S., the development in England, Germany, Belgium, Denmark, France, Italy, Yugoslavia, the Netherlands, Norway, Austria, Poland, Rumania, Sweden, Switzerland, USSR, Czechoslovakia, and Hungary. Other countries are mentioned and references to pertinent literature given, only to illustrate this worldwide effort and to show the impossibility for achieving completeness in this enumeration. A selection of digital computer literature is annotated and most journals which deal primarily with applications of digital computers are listed. Review journals are also given. The bibliography lists 697 titles, almost 30 percent of all titles combined in the entire 22 articles.

While few will read the entire book, it should be interesting to many who wish to inform themselves about those disciplines of computer science and developments outside their own activities.

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