Abstracts

from recent papers by IBM authors

An Annotated Descriptor-Based Bibliography of the Use of Computers for Non-Numerical Mathematics, J. E. Sammet, *Computing Reviews* **7**, No. 4, B1–B31 (July-August 1966). This bibliography contains about 300 items related to the use of computers for non-numerical mathematics. This includes the fields of (1) theorem proving, (2) "pure" mathematics, (3) formula manipulation, and (4) tools for items 1 to 3. Each article has a complete citation, and has been given an annotation and a set of descriptors. Computer listings sorted by code number, descriptor, author, and date are included. The introductory section contains a list of system names with a one-sentence description of each.

The Application of a Few Hyperplane Decision Techniques to Handprinted Character Recognition, D. D. Johnson, C. F. Haugh, and K. P. Li, *Proceedings of the National Electronics Conference* **22**, 869–873 (1966). Because of cost, size, and speed limitations, it is often impractical to use as many as n hyperplanes to separate n distinct classes. The restriction to m hyperplanes ($m \leq n$) influences the design of output codes and training algorithms. This paper reports on the use of ten hyperplanes for the classification of ten handprinted digits, twenty-six handprinted block alphabetics, and thirty-six handprinted alphanumerics. The data gathering system, which obtains no sequential information from the pattern, and a set of loose constraints on character formation are described briefly. Results obtained using various training algorithms, output codes, and recognition techniques are compared and analyzed. All results were obtained by computer simulation. Inferences for future development work are drawn and discussed.

Artificial Satellite Orbit Computations, P. Sconzo, *Proceedings of the International Astronomical Union, Symposium No. 25, The Theory of Orbits in the Solar System and in Stellar Systems,* 363–371 (1966). In this paper an orbit computation program for artificial satellites is presented. This program is operational and it has already been used to compute the orbits of several satellites. After an introductory discussion on the subject of artificial satellite orbit computations, the features of this program are thoroughly explained. In order to achieve the representation of the orbital elements over short intervals of time, a drag-free perturbation theory coupled with a differential correction procedure is used, while the long range behavior is obtained empirically. The empirical treatment of the non-gravitational effects upon the satellite motion seems to be very satisfactory. Numerical analysis procedures supporting this treatment and experience gained in using our program are also objects of discussion.

Automated Facilities Layout Programs, J. M. Seehof, W. O. Evans, J. W. Friederichs J. J. Quigley, *Proceedings of the ACM 21st National Convention,* 191–199 (1966). This IBM 7090/1401 commercial plotter computer program optimizes organizational positioning (layout) based on (1) a preference table indicating organizational placement desires, (2) preselected mandatory positioning for areas such as elevators, (3) square footage per organizational unit. The organizational unit is not restricted and may be a department, machining area, chemical lab, person, pieces of equipment, etc. Results are produced in graphic form for the designer. The program can be used for layouts of a manufacturing floor, for floor plans, office space within a department, school buildings, playgrounds, cities, lunar bases, etc., with the preference table and scoring table set up to reflect a given application.

Bibliography on Network-Based Project Planning and Control Techniques, S. Lerda-Olberg, *Operations Research* **14,** No. 5, 925–931 (September/October 1966). An inexhaustive bibliography covering 78 papers in English, 15 in other languages and 16 books on the subject of PERT, CPM, and related techniques are given. All articles were published in well-known journals during the years 1962–1965. The English language papers are classified as to General, Theory, Programming, and Applications.

Computer Control of a Kraft Paper Machine, A. Ekstrom and G. Sangregorio, *Proceedings of the Paper, Rubber, and Plastics Automation Congress,* Antwerp, C8-1–C8-11 (1966). At the Billerud paper mill at Gruvön, Sweden, an IBM process-control computer is used for an integrated system with several functions including closed-loop process control, quality control and production supervision of a large kraft-paper machine. Production planning for the whole paper mill is also included. This paper first presents a summary description of the integrated system and its objectives, and then deals in more detail with the closed-loop control of the paper machine.

A Computer-Oriented Method for Analyzing Networks with RLC Elements and Ideal Transformers, K. Lock, *Proceedings of the Western Electronic Show and Convention (WESCON),* 1/1/1–19 (1966). A method is presented for formulating networks of RLC elements and ideal transformers in terms of properly selected node-pair voltages which minimize round-off errors arising from matrix inversions. Algorithmic methods suitable for implementation into computer programs are given for both complex frequency plane and transient analyses. Using the same approach, methods are developed for analyzing networks by partition, which should prove very valuable in handling networks of extremely large size, many common networks, or localized nonlinear elements.

A Computerized Radioisotope-Scan-Data Filter Based on a System Response to a Point Source, D. W. Chaapel, A. C. Sprau, and W. N. Tauxe,* *Mayo Clinic Proceedings* **41,** No. 9, 585–598 (September 1966). This article deals with the development of programs that solve the problem of inconsistent resolution in current scintiscanning devices by using a digital computer. Functionally, the process behaves as a mathematical "filter." Scintiscan information is gathered and stored by a multichannel digital tape recorder. This tape is used as direct input to an IBM 7040 computer. In a preliminary clinical series, this filtering process afforded a significant improvement in scintiscans, because each of as many as 20 levels of coming-rate intensity could be clearly separated and represented by a symbol.

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For A Crew in Lonely Orbit, Something to Lean On in Space, A. Adelman and J. Cohen, *Electronics* **39,** No. 20, 129–138 (October 3, 1966). A brief portrait is projected of the kind of computer system that in coming years will help man exploit space in an orbiting laboratory. The system will be the operating center of the orbiting laboratory and the link that joins men and equipment in space to their counterparts on the ground. In addition to providing guidance and navigation aid as do current spacecraft systems, the more flexible and sophisticated future aerospace computer will check out onboard systems and experimental equipment, support the performance of experiments, and manage a large volume of experimental data. To meet these needs, it will be necessary to design a new concept general-purpose computer. The possible configuration of such a computer and how it will interface with related equipment is discussed.

All Digital Simulation of Saturn I, IB and V Boost Vehicle and Guidance and Control Systems, W. D. Carson, R. E. Poupard, T. D. Steele, and F. W. Eubank, *Supplement to IEEE Transactions on Aerospace and Electronic Systems* **AES-2,** No. 4, 809–819 (July 1966). In Saturn I flights an all-digital simulation was used in preflight verification of the onboard computer's flight program, and in postflight evaluation to investigate any unpredicted inflight behavior. An equivalent simulator is being used for the uprated Saturn I and V vehicles. Saturn IB and V simulators are more complex and are being applied more extensively to the design and checkout of the onboard computer's flight program. This paper traces the early development of the Saturn I simulator and subsequent verification of its math models during the SA-6 flight. A description is given of the simulator's construction and the problems presented in the development of such a simulator, with special attention given to the problem of simulating the flight computer.

A Discrete Design Method for Digital Control, R. W. Koepcke, *Control Engineering* **13,** No. 6, 83–89 (June 1966). When considering discrete systems, control engineers tend to pose a continuous problem, find the continuous solution, and then invoke z-transforms to obtain the discrete solution. Filtering then becomes complicated because folding frequency effects and the sampling theorem assume exaggerated importance. The net result of the procedure is to create the impression that discrete systems are poor imitations of continuous systems. Here is a more direct approach—a discrete design technique for two-mode control.

Eliminating Monotonous Mathematics with FORMAC, R. G. Tobey, *Communications of the ACM* **9,** No. 10, 742–751 (October 1966). The FORMAC (FORmula MANipulation Compiler) programming system provides an extension of FORTRAN IV which permits the use of the computer to perform the tedious algebraic computations that arise in many different fields. Among the areas in which it has been successfully used are: differentiation of complicated expressions, expansion of truncated power series, solution of simultaneous equations with literal coefficients, nonlinear maximum likelihood estimation, tensor analysis, and generation of the coefficients of equations in Keplerian motion. These types of analyses—which arose in the solution of specific practical problems in physics, engineering, astronomy, statistics, and astronautics—are discussed in the paper. In addition to its use for specific problem solutions, FORMAC can also be used to automate the analysis phase in certain production programming. Several such applications are presented.

Extending Image Reproduction System Analysis to Include the Observer, C. K. Clauer, *Proceedings of the Seventh National Symposium on Information Display,* 9–13 (1966). Image reproduction systems such as photographic projection and television displays produce a visual display which is an analog reproduction of a source pattern. The technique of employing a modulation transfer function (MTF) to characterize image reproduction systems of all kinds has been found very useful for predictive analysis. While such analytical methods are effective for characterizing physical image systems, they have not provided quantitative evaluation of the display from the observer's viewpoint. Recently, efforts have been made to define a modulation transfer function that characterizes a standard human observer and could be combined with the MTF of the physical image system to evaluate the total display-observer system. This approach can be shown to be invalid, since the human visual system, unlike the physical system, does not respond at all at contrast levels below the contrast threshold and, above this threshold, responds as a *non*linear function of modulation (contrast). This paper proposes a graphical method for extending image reproduction system analysis to include the observer. A procedure is outlined for plotting the contrast threshold function of a standard observer on the same coordinates as the system modulation transfer function; obtaining difference values which represent the objective physical modulation (or contrast) transfer above threshold; and finally, converting the physical modulation levels above threshold to the Munsell psychophysical response scale.

General Analytical Model for Process Analysis, R. G. Kiwimagi and R. E. Watson, *Proceedings of the 30th National Meeting of the Operations Research Society of America* **14,** Supplement 2, B217 (October 1966). The General Analytical Model for Process Analysis was developed to furnish a convenient means of evaluating a change in a process in terms of equipment utilization, manpower, and product cost. The program was designed to handle processes which include several parts using the same equipment, many scrap points and recycles, as well as varying cycle times and scrap rates per recycle. The program is able to handle a three-dimensional matrix 100 × 18 × 5. This consists of up to 100 operations, up to 18 different products (or parts) sharing all or some of these operations, and up to 5 cycles per operation.

LISA—A Program for Linear Systems Analysis, K. L. Deckert and E. T. Johnson, *Proceedings of the Western Electronic Show and Convention (WESCON),* 1/2/1–9 (1966). LISA is an integrated package of experimental 7090/94 FORTRAN IV programs for analyzing linear systems using Laplace transform techniques. It will analyze electrical networks, two-block control systems, and any system of linear equations whose coefficient matrix has polynomial elements. Inputs may be a topological circuit description, transfer function, matrix equation, or block diagram. Outputs may be poles and zeros, frequency and transient response, root locus, or sensitivity. Both listings and plots may be obtained. LISA features a free format, applications-oriented input language, with extensive user control of output. This makes it suitable for terminal operation. Several computational and programming techniques extend the size of problems the program can handle, reduce computation time, and conserve storage. The program is organized to be open-ended so that new features may easily extend its capabilities.

Necessary and Sufficient Conditions on Conditional Probabilities to Maximize Entropy, C. E. Radke, *Information and Control* 9, No. 3, 279–284 (June 1966). Shannon showed that, by a proper choice of the conditional probabilities of the symbols in a discrete noiseless channel of the finite-state type (which possesses certain inherent constraints), the entropy of symbols on such a channel could be maximized. To date, these known sufficient conditions on the conditional probabilities have been assumed to also be the necessary conditions. In this paper it is shown that the sufficient conditions as originally stated by Shannon are indeed also the necessary conditions for the range of symbol lengths which are of interest.

On-Line Processing of Library Materials with the IBM Administrative Terminal System, T. D. Phillips, *Proceedings of IFIP Congress* 65, Volume 2, 343–344 (1966). Proceeding in experimental stages from a conventional manual system to simple punched-card procedures for isolated functions, and then to a computer-based system, integrating all the library functions, the library in the Los Gatos Laboratory of IBM's Advanced Systems Development Division has repeatedly faced the necessity of converting existing files to machine-readable form. The present system is designed to process library materials rapidly and to keep the records for each book accurate and current. In implementing this system, we have applied IBM's Administrative Terminal System to several tasks to great advantage. ATS is a beginning answer to the troublesome problems of file conversion, and is particularly suited to on-line processing.

A 110 Nanosecond Ferrite Memory, G. E. Werner and R. M. Whalen, *IEEE Transactions on Magnetics* **MAG-2**, No. 3, 584–588 (September 1966). The design of a large, very high-speed ferrite memory is described. The memory has a capacity of 8192 words, 72 bits per word and has a cycle time of 110 nanoseconds and an access time of 67 nanoseconds. The storage devices are miniature ferrite cores, size: 0.0075 in. by 0.0123 in. by 0.0029 in. and are operated in a two-core-per-bit mode. A planar array geometry with cores resting on a single ground plane was used to control drive line parameters. Device switching speed and bit line recovery are treated as special problems. The design criteria and operational characteristics of the core are presented as well as the approach taken on the bit line recovery problem.

Paper Machine Identification for Purposes of Computer Control, T. Bohlin, *Proceedings of the Paper, Rubber, and Plastics Automation Congress*, Antwerp, 1–23 (1966). Results are presented of the application of a method of dynamic regression to the estimation of dynamics and disturbance characteristics of a kraft paper machine at a paper company in Sweden. The method is related to one developed by G. E. P. Box and G. M. Jenkins. The models obtained as results of the identification are in such a form that the optimal steady-state control algorithms are immediate and simple. Among the relationships identified are models for control of basis weight, moisture and couch vacuum through refiners. The corresponding optimal control algorithms have been put into an IBM 1710 control computer attached to the process. The technique is fairly general and can be applied to stationery industrial processes. Equipment for data logging must be available.

Parallel Processing of Algebraic Expressions, H. Hellerman, *IEEE Transactions on Electronic Computers* **EC-15**, No. 1, 82–91 (February 1966). A classification of parallel processing is first offered. A compiler algorithm is given for translating algebraic expressions to concurrency groups of instructions for a parallel-processor system. A machine organization to execute such a compiler program is described.

The Readback Process in Digital Magnetic Recording, J. R. Herbert, *IEEE Transactions on Magnetics* **MAG-2**, No. 3, 247–251 (September 1966). Losses in analog magnetic recording can be separated and analyzed by frequency response techniques. In digital recording these cannot readily be applied but, as this paper shows, useful results can be obtained from a time domain analysis of the readback process. The commonly accepted model of this process as a convolution of the media magnetization transition and the head field function is extended by the use of linear theory to include the electrical parameters of the head amplifier system. The resultant model is then analyzed to show how the three contributions to the readback process, the written transition, the head field, and electrical effects—might be separated by suitable experimental techniques. Electrical effects are readily separable and experimental results agree well with both the theory and established head parameters. The separation of reading and writing effects is shown to be difficult to achieve under conditions likely to be encountered in practice, but an approximate method is discussed.

A Simulation Approach for Evaluating System Packaging, S. Fielden and A. Kimer, *Proceedings of the 7th International Electronic Circuit Packaging Symposium*, Section 3/8, 1–11 (August 1966). A method is described which permits a study of a proposed packaging technology and its economic impact on a corporation. The simulation model is general in nature and evaluates the effects of such processes as the building of the product, field installation, field stocking, maintenance and engineering change activity, for a simulated time period. The aggregate measures made up of fixed costs and operating costs are deemed to represent the long term consequences of employing the strategy being simulated. Any change in input conditions, in simulated policies, or in options allowable in the model implies a change in strategy or packaging philosophy.

Systematic Generation of Hamiltonian Circuits, S. M. Roberts and B. Flores, *Communications of the ACM* 9, No. 9, 690–694 (September, 1966). For a combinatorial matrix which may specify both directed and non-directed arcs, the paper describes a computer program which generates systematically and exhaustively all the Hamiltonian circuits. Specific application is made to the "travelling salesman" problem.

A Terminal Operated Production Program (TOPP) System, R. J. Hedger, A. G. Pontius, J. M. Seehof, and G. G. Benson, *Proceedings of the ACM 21st National Convention*, 167–177 (1966). This paper describes an IBM 1050/7090 terminal system that allows remote execution of library programs (mathematic analysis, information retrieval, engineering design) utilizing the full capability of the IBM 7090. High efficiency is obtained by time-sharing the terminal input/output data transmission and library tape positioning with normal IBSYS background activity. Programs with limited input and output volume, written under IBJOB (FORTRAN IV, COBOL, MAP) can be readily adapted for terminal use. System applications, philosophy, and limitations are discussed.

A Theoretical Model for a Quantitative Evaluation of Magnetic Recording Systems, B. Kostyshyn, *IEEE Transactions on Magnetics* **MAG-2**, No. 3, 236–242 (September 1966). In designing a digital magnetic recording system, it is necessary to consider a large number of parameters to produce optimum performance. Because of parameter interdependence, and the nonlinear nature of the recording process, experimental evaluation of a real system is cumbersome, time-consuming, and costly. To circumvent the usual trial and error techniques, a model has been developed based on earlier work of the author; it enables a rapid quantitative evaluation to be made of the performance of a system employing saturation magnetic recording. The analysis is separated into two parts: the first is designed to characterize the recording system, and the second, the encoding system. For the former, the signal amplitude and the harmonic content of a reference pattern are of interest; for the latter, the calculated signal traces of complex bit patterns are of interest.

Tomorrow's Manager and Displays, D. A. Lehman, *Data Processing* **11**, (Proceedings of Data Processing Management Association, 1966). A fully management-oriented information system must include immediate access to numerous data bases, and should present all needed information in one convenient form, whether the information comes from digital storage or from, for example, a magnetic image file. The computer power, image storage technology, conversion equipment, and software now available make such a system a practical possibility. With a television terminal in the executive office to accept inquiries and display responses, the system subordinates all other requirements to the needs of the user. Displaying alphanumeric, graphic and pictorial information on demand or as programmed (in an Attention file, for instance), the terminal becomes the personal tool of the executive. The television screen itself is overlaid, in effect, by a touch matrix which identifies positions on the images displayed, and thus permits a simple but infinitely variable inquiry language.