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OF AUTOMATIC CONTROL

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Honorary Editor of IFAC

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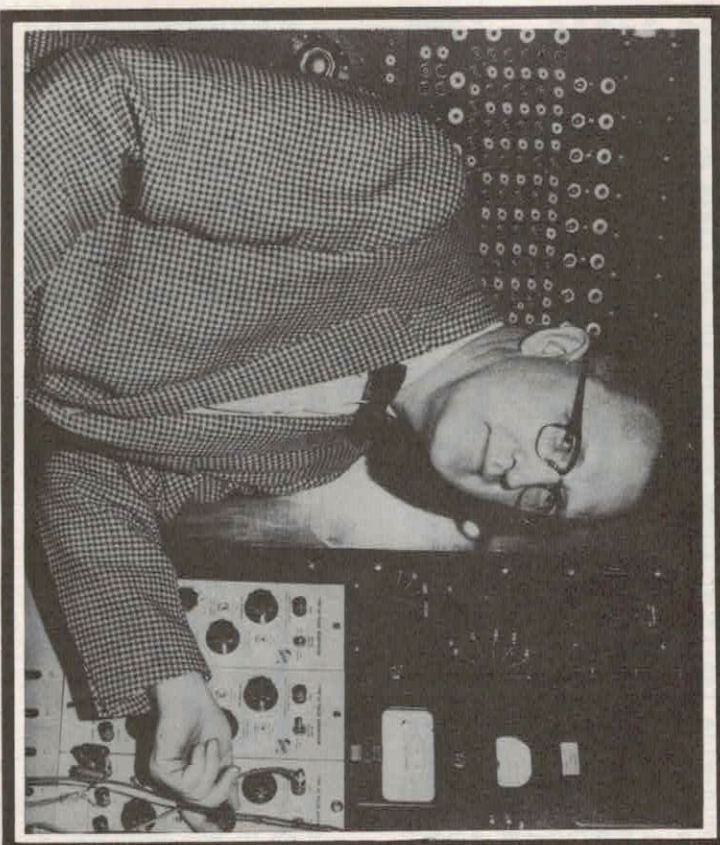79, Prinz-Georg-Str., Düsseldorf (Germany)

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PUBLICATIONS

IN MEMORIAM

DONALD P. ECKMAN

During its meeting at Cambridge, the Executive Council of IFAC was informed of the tragic death on May 26, 1962, in a car accident on his way to Cambridge, of prof. Donald P. E c k m a n, Chairman of the IFAC Advisory Committee since 1957.

With the death of D.P. E c k m a n, IFAC has lost one of its most devoted officers who has served our Federation unto the final moments of his life. His contributions to the Automatic Control field as a teacher, scientist and author of universally accepted technical books are widely known throughout the world. Already in Bulletin no. 11 (pages 34 to 36) we have published an account of the Systems Research Center at the Case Institute of Technology, Cleveland, which was created and directed by Don E c k m a n. We publish in this issue further details of the work of this Center which reached us shortly before this tragic news.

All Automatic Control engineers throughout the world in meeting Donald P. E c k m a n felt of him, immediately as a friend and many remember with affection the hospitality of his family and home. His death is a great loss for all who knew him and the sorrow of his own family is fully shared by the whole world-wide family of those who work in the field of Automatic Control.

Without doubt, his fine example will inspire more scientists and engineers to follow his investigations in the field of Automatic Control and encourage all those already engaged in this field to devote their best efforts to promote Automatic Control science amongst nations. Don E c k m a n would have wished for no better reward of his activities and this remains the best possible tribute to his memory.

May the present issue of the IFAC Bulletin - the largest ever published since its foundation - be a first and modest token of remembrance to Donald P. E c k m a n from his companions and friends.

The Editor

Some dates of the life of Donald P. E c k m a n

December 31, 1915 - Birth in Hillsdale, Michigan, USA

1934   Graduated from Jackson Junior College

1938   Bachelor of Sciences, University of Michigan

1939   Master of Sciences (Mechanical Engineering), University of Michigan

1939 – Research engineer with the Brown Instrument Company,
1946   Philadelphia, Pennsylvania

1946 – Teaching fellow and instructor, Cornell University,
1950   Ithaca, New York

1950   Philosophy Doctor, Cornell University

1950   Member of the teaching staff of the Case Institute of Technology, Cleveland, Ohio, and, later, professor of Mechanical Engineering of same

1957   Chairman of the Advisory Committee of the International Federation of Automatic Control (IFAC)

1959   Director of the Systems Research Center of the Case Institute of Technology

1959   Annual Award of the American Society of Mechanical Engineers

Main publications (personal books)

"Principles of industrial process control", New York, 1945
"Industrial instrumentation", New York, John Wiley, 1950
"Automatic process control", New York, John Wiley, 1958
"Systems; research and design", New York, John Wiley, 1961

IFAC NEWS

Meeting of the Executive Council at Cambridge

Meetings of the IFAC Executive Council were held at Cambridge, United Kingdom, on June 4, 5 and 7, 1962. A meeting of the IFAC Technical Committee on Bibliography was held at the British Institution of Electrical Engineers in London on June 6.

After the members and guests of the Executive Council had heard, standing in silence, the announcement read by professor Ed. G e r e c k e, President of IFAC, of the death of Professor Donald P. E c k m a n, Chairman of the Advisory Committee, the President delivered the following report:

PRESIDENT'S REPORT 1962

The first contacts for the creation of IFAC were made at Heidelberg (Germany) in 1956 and attended by Dr. R u p p e l, professor B r o i d a and the present President. IFAC was founded at Paris in 1957 and Mr. C h e s t n u t was elected as first president. The annual meetings of the Executive Council were held at Zurich in 1958, at Rome in 1959, at Chicago in 1959, at Moscow in 1960, at Bergen in 1961 and now at Cambridge in 1962. The Constitution and By-Laws of IFAC were completed in 1959. The first large-scale IFAC event was the first international congress at Moscow in 1960 with professor L e t o v as second President. The Proceedings "Automatic and Remote Control" were published in 1961 by Butterworths Scientific Publishers in four volumes with a total of 2016 pages containing 286 papers. An edition in Russian language was published by "International Book", Moscow. These Proceedings reflect the high scientific level of IFAC and advanced state of the theory on automatic control.

ELECTIONS

In autumn 1961 the new Executive Council was elected by the National Members in accordance with the proposals of the former Executive Council. The President would like to thank the National Members for his election as third President of IFAC. As the Honorary Secretary, Dr. G. R u p p e l, and the Honorary Editor of the IFAC Bulletin, professor V. B r o i d a, have to be reappointed every year, these two IFAC officers are reappointed to their positions for 1962. Special acknowledgement was made of these officers' devotion. The President realizes that Dr. R u p p e l works a large part of his time for IFAC and trusts the Executive Council will thank him cor-

dially for his really good work. The President would also like to express the thanks of the Executive Council to the VDI at Düsseldorf and hopes that Dr. Ruppel will continue his IFAC activity after the Second IFAC Congress in 1963. The Honorary Editor has published three IFAC Bulletins between the meetings at Bergen and Cambridge and the President knows that this is a heavy duty. Professor Broida is fluent in the four IFAC languages and his translation work at the Rome Symposium was much appreciated. The President hopes it will be the wish of the Executive Council that he expresses thanks on behalf of IFAC to professor Broida for his excellent work.

In connection with the IFAC Technical Committees the President has received a letter from professor Naslin, Paris, who wishes to resign as Vice-Chairman of the Technical Committee on Theory because of overwork. Dr. Mozley, USA, also resigned as Chairman of the Technical Committee on Applications.

PARTICIPATION OF IFAC IN EVENTS OF OTHER ORGANIZATIONS

a) European Federation of Chemical Engineering

Dr. Ruppel was present as IFAC representative at the first meeting of the Working Party on Chemical Process Automation at Frankfurt, Germany, on June 10, 1961.

Dr. Wohler, member of the Swiss Federation of Automatic Control, was present at the meeting of the Documentation Committee of the Working Party on Chemical Process Automation at Basle on September 21, 1961. He presented the IFAC Classification which was adopted with the wish to extend it more to Chemical Processing.

b) IMEKO

Professor Letov, professor Coales, Dr. Borowisza and members of the Technical Committee on Components cooperated with IMEKO and attended the IMEKO Exhibition at Budapest in June/July 1961.

c) Symposium on Automatic Control of large power station groups

Dr. Ruppel attended this meeting as IFAC representative at Prague, in September 1961.

d) UNESCO Symposium "Man in Space"

In November 1961 professor Broida was present as representative of IFAC and UATI at the meeting of the Study Group for preparing a Symposium "Man in Space" in Paris.

e) Application of digital methods in automatic control

Professor Coales and the President were representatives of IFAC as honorary guests at this meeting of VDI/VDE from March 13 to March 15, 1962 at Heidelberg.

f) MESUCORA

The President was present as the representative of IFAC during the whole exhibition from May 8 to May 13, 1961 in Paris. During this large exhibition lasting a week, papers were read at special meeting on Components for Measurement and Automatic Control.

g) ISO/IEC

ISO (International Standards Organization, Geneva) and IEC (International Electrotechnical Commission, Geneva) invited on May 15, 1961 at Geneva several international federations to discuss the problem of further standardization in automatic control and information processing. The President represented IFAC and reported on the IFAC work on graphical symbols. ISO created an ISO Committee 97 for:

Digital Computers and Information Processing,

and IEC a Technical Committee (TC) 53 for:

Computers and Data Processing Equipments.

The committees decided to cooperate with IFAC.

h) IEC meeting

At the IEC meeting in Interlaken, Switzerland, the President gave a review of the IFAC graphical symbols. The IEC decided to nominate a committee for the electrical section of these symbols and to cooperate with IFAC. The meeting took place in June 1961.

i) VDI/VDE-Fachgruppe Regelungstechnik, Germany

The VDI/VDE-Group for Automatic Control decided in 1960 to work on graphical symbols for automatic control. The working group after noting the report in the IFAC Bulletin (see no. 6 of January 1960) invited the President to speak for 2 hours on IFAC symbols at Frankfurt on January 17, 1962 before a hundred specialized engineers. The President was then invited to read a paper on: "Signal flow diagrams and graphs in the Education program of a Technical University" at Karlsruhe on May 24, 1962. The VDI/VDE

Group is the only national organization actively working on graphical symbols. Very good cooperation exists with IFAC.

k) I B R A

IBRA is the Belgian National Member of IFAC and has organized an International Seminar on Automatic Control in the Iron and Steel Industry, Brussels, February 1962. This meeting was sponsored by the IFAC Technical Committee on Applications and attended on its behalf by Mr. S i l l s, USA.

i) A I C A 1 9 6 1

The International Federation of Analog Computation (President professor H o f f m a n n, Brussels) held a Congress at Opatija, Yugoslavia in September 1961 which dealt with applications of analog computers to automatic control. Dr. T o m o v i c , Vice-President of AICA, asked for extensive cooperation between IFAC, IFIP and AICA in the field of applications of analog computers. The President was present at this meeting as representative of IFAC and also as Vice-President of AICA and promised to submit this question to the Executive Council of IFAC. At the Second IFIP Congress in Munich, Germany, August 1962, this question will be discussed between IFIP, AICA and IFAC.

IFAC TECHNICAL COMMITTEE ACTIVITIES

The Technical Committee on T h e o r y held at Rome from April 26 to 28, 1962 its first Symposium on :

O p t i m i z i n g   S y s t e m s   a n d   s e l f - a d a p t i v e
S y s t e m s   T h e o r y .

Papers were at a really high level and interesting discussions took place. About 65 persons were present. The President would like to thank the Italian Member Organization of IFAC for its excellent hospitality.

The Technical Committee on C o m p o n e n t s had a meeting in Parie in May 1962.

The Technical Committee on B i b l i o g r a p h y has published the Classification prepared by professor B r o i d a and the first issue of the Bibliography itself is now published.

In the Technical Committee on T e r m i n o l o g y, work was done on graphical symbols.

Bulgaria, Turkey, Netherlands, Denmark and China were invited to participate in committee work and in providing information for the Bulletin.

PREPARATION OF THE SECOND IFAC CONGRESS 1963 AT BASLE
(SWITZERLAND)

In August 1961, printed invitations to authors were mailed to the National Members. Up to May 20, 1962 about 2 6 5 papers were offered to IFAC (Russian papers not included), namely on:

Theory	101 papers
Components	17 papers
Applications	106 papers
Non classified	41 papers

In May 1962 special instructions were sent to authors. The Swiss Federation of Automatic Control is working intensively on the organizational and financial matters for the Basle Congress.

Tenders for the Proceedings of the IFAC 1963 Congress were submitted to Dr. R u p p e l . A list of reviewers has been established by the Technical Committees on Theory and Components.

GENERAL SITUATION OF IFAC

IFAC has now grown up to a serious scientific and engineering organization. In the different fields of IFAC activities, good work has been done and the officers and members of the Technical Committees are spending more and more of their time on IFAC. Therefore only persons who are willing and in a position to serve IFAC should be appointed in the future. The cooperation of other international or national organizations with IFAC is under way. The goals of IFAC are the further development of systems engineering and applications for small and large plants. After the IFAC Congress 1963 small Symposia should take place between specialists in different fields to stimulate further progress.

After approval of the President's and of the Treasurer's reports, the Executive Council in its meetings at Cambridge discussed the following problems (some of which were also discussed at the meeting of the Technical Committee on Bibliography held in London) and made the following decisions:

APPOINTMENT OF COMMITTEE CHAIRMEN AND VICE-CHAIRMEN

The following appointments (*) or re-appointments were made:

A d v i s o r y   C o m m i t t e e
Chairman: Mr. Harold Chestnut (USA) (*)
Vice-Chairman: Mr. J. Loeb (France)

T e c h n i c a l   C o m m i t t e e s   o n :

A p p l i c a t i o n s :
Chairman: Mr. W.E. Miller (USA) (*)
Vice-Chairman: Dipl.-Ing. V. Strejc (Czechoslovakia)

B i b l i o g r a p h y :
Chairman: Mr. M. Ajnbinder (Belgium)
Vice-Chairman: Dr. B.N. Naoumow (USSR)

C o m p o n e n t s :
Chairman: Dr. Gy. Boromisza (Hungary)
Vice-Chairman: Professor Y. Oshima (Japan)

E d u c a t i o n :
Chairman: Mr. M. Pélegrin (France) (*)
Vice-Chairman: Rector Z. Szparkowski (Poland)

T e r m i n o l o g y :
Chairman: Professor Ed. Gerecke (Switzerland)
Vice-Chairman: Dr. H.L. Mason (USA)

T h e o r y :
Chairman: Academician B.N. Petrov (USSR)
Vice-Chairman: Professor J.H. Westcott (United Kingdom) (*)

SECOND IFAC CONGRESS

This Congress to be held in Basle, Switzerland, will begin on Wednesday, August 28, 1963 and end on Wednesday, September 4, 1963, both dates being inclusive.

In addition to the papers provided by authors, some review papers are anticipated.

After an initial selection by National Member Organizations, papers will be perused by Chairman and Vice-Chairmen of the corresponding IFAC Technical Committees and finally selected by an IFAC Selection Committee.

The Proceedings will be published in two versions:

- one in English, French or German,

Professor V. Broida (France) has been appointed Chief Editor of this Western version. He will be assisted by two co-editors.

- one in Russian, under the responsibility of the Institute of Automatics and Telemechanics of the USSR Academy of Sciences.

Both Western and Eastern Editors will closely co-operate.

BIBLIOGRAPHY

The members of the Executive Council in Cambridge had the opportunity of seeing the first issue of the International Bibliography of Automatic Control (936 references) issued shortly before the meeting, edited by professor V. Broida and published by Presses Académiques Européennes, Brussels.

The members of the Technical Committee on Bibliography were also shown in course of their meeting at London, held under the chairmanship of Mr. M. Ajnbinder and attended by Dr. Perez-Vitoria (UNESCO) and Mr. Trocki (Presses Académiques Européennes), the full dummy-proof of the second issue of this Bibliography (976 references) published since (the third issue of 1032 references being presently on press).

The following decisions have been made by the Executive Council in respect of the Bibliography:

1) To approve the results already achieved and to recommend the continuance of this project. Thanks were expressed to professor V. Broida and to Mr. M. Ajnbinder.

2) To strongly urge National Member Organizations to increase their co-operation in the project to the utmost by ensuring a regular flow of information to the Editor and by actively promoting, diffusing and sollicitating sales of the Bibliography.

3) To authorize the Technical Committee on Bibliography to negotiate with Presses Académiques Européennes a contract for continuing this publication. The latter is presently supported by the Exact and Natural Sciences Department of UNESCO but will have to become ultimately self-supporting in future.

4) To request the Technical Committee on Bibliography to negotiate a contract with Presses Académiques Européennes for publication of the past bibliography on automatic control up to and including 1960. This new project is to be entirely self-supporting, including editorial expenses.

IFAC BULLETIN

In his report to the Executive Council, professor V. B r o i - d a , Honorary Editor of IFAC, called the attention of National Member Organizations to the very urgent necessity for some of them to greatly increase their contribution to the IFAC Information Bulletin which has to reflect automatic control events and trends on a w o r l d w i d e b a s i s .

NEXT MEETING OF THE EXECUTIVE COUNCIL

The next meeting of the Executive Council is scheduled in Zurich, Switzerland, from March 20 to 22, 1963.

SOCIAL EVENTS

Many examples of generous and friendly British hospitality were displayed during the sessions at Cambridge, parties being invited by the Engineering Laboratory of the Cambridge University and by professor and Mrs. J.F. C o a l e s . In addition IFAC members were guests at traditional dinners at various Colleges. In London the party were guests of the British Conference on Automation and Computation and besides attending the meeting of the Technical Committee on Bibliography, members and guests of the Executive Council visited technical laboratories.

Industrial visits were also made and on every occasion private British firms displayed the same generous hospitality (including an evening at the Covent Garden Opera House) which was much enjoyed by all participants.

International Symposium on Relay Systems Theory and Finite Automata

An International Symposium on Relay Systems Theory and Finite Automata will be held in Moscow from September 24th to October 2nd, 1962 by the IFAC Technical Committee on Theory jointly with the USSR National Committee on Automatic Control. Attendance is restricted to personally invited experts.

The following areas of relay systems theory, proposed at the 1st Congress of IFAC, are to be discussed:

1) Problems of language describing the operation of relay devices and suitable algorithms for deriving flow tables.
2) The problem of assignment, taking into account hazards.
3) Problems of minimization of the structure of relay devices by:

a) algorithms for the minimization of "factored" Boolean expressions,

b) algorithms for designing "bridge" (non-series parallel) contact networks,

c) approximate methods of minimization.

4) Problems of mechanization of the synthesis and the analysis of relay devices, using special and general purpose computers.
5) Problems of reliability of relay devices.
6) Relay devices, finite automata, logical networks. Conjunction, difference, possibilities of unification of these concepts.
7) Various optimization criteria for relay devices.
8) Methods of synthesis of the structure of ordered relay systems.
9) Methods of synthesis of structures with pulsed elements.

The proceedings of the Symposium will be published.

IFAC Symposium on Self-Adaptive Systems

This Symposium, organized by the IFAC Technical Committee on Theory jointly with the Commissione Italiana per l'Automazione, National Member Organization of IFAC for Italy, took place in Rome on April 26-28, 1962.

Morning session, April 26 — Chairman: professor A. M a - r i n o (Italy)

After welcome speeches held by professor G. P o l v a n i , President of the National Research Council of Italy, by professor A. M a r i n o , Chairman of the Commissione Italiana per l'Automazione, and by academician B.N. P e t r o v (USSR), Chairman of the IFAC Technical Committee on Theory, the following papers were read (abstracts of which are given hereafter):

RECENT WORK IN OPTIMIZATION AND ADAPTATION

review paper by professor John G. T r u x a l (USA), Chairman of the IFAC Subcommittee on Self-Adaptive and Optimal Theory

THE OPTIMAL METHODS OF SEARCH IN CONTINUOUS AND PULSE EXTREMUM CONTROL METHODS

by professor A. K r a s s o v s k i i (USSR), read in Russian by Dr. B.N. Naoumov and translated into English by professor V. Broida.

The search process in continuous and pulse extremum control systems includes the process of determining deviations from the extremum and the process of approaching the extremum. These processes may take place simultaneously or in succession with respect to time.

Each process can be achieved in different ways producing a large number of search variants. This is particularly so in cases when the characteristics of a multidimensional plant have several extrema, of which only the main unknown one is sought.

The paper is devoted to the consideration of these several problems of optimum search. One of such search occurs when the maximum accuracy is to be achieved within the defined time or when minimum search time is realized compatible with in the specified accuracy of determining the extremum coordinates.

It is proved that, under fairly general conditions, the operation for determining gradient components which is optimum amongst all the linear operations considered is a synchronous detection of the form:

$$U_j = \frac{1}{\delta x_j^2 . T} \int_{t-T}^{t} \delta x_j \, F \, dt$$

where δx_j is the orthogonal search element of ideal plant input put coordinate.
F is an output value of the plant including noise affecting outputs and inputs.
T is the period of the lowest frequency search signal.

Search oscillations of continuous, pulse and compound forms are compared. It is proved that with respect to the accuracy of determination of the characteristic gradient of a multidimensional plant within the specified time, the continuous search oscillations and, particularly, harmonic oscillations are advantageous.

It is shown that in continuous search systems the peculiarities of "comb"-type cannot give any false stationary points.

The search methods in the presence of several extrema are discussed. It is shown by means of rough estimations that the compound search including the blind search of extrema areas with motion along the gradient vector in these areas can give a great improvement with respect to the total search time in multidimensional systems.

DYNAMIC PROGRAMMING FOR DIRECT OPTIMIZATION

by professor Akira N o m o t o (Japan)

Optimizing control is frequently achieved on the direct-acting scheme. Without preparing a model of the objective system a priori, the system measures the return function or the response surface as a direct outcome of the system. Search strategies are performed to attain the optimum or the extremum condition.

This approach requires smaller equipment complexity and possesses self-adaptibility in respect of changes in the system's characteristics as control action always starts from direct measurement of the system.

It seems more realistic to build a system working on the sequence of discrete-step actions, each consisting of the model construction and the orientation to the optimum condition. In this sense, systems of direct optimization can be regarded as multi-decision processes, involving successive designs of experiments. To formulate the algorithm, the notion of sequential decision or dynamic programming is utilized. To begin with the simplest system where the return function is completely known, basic functional equations are deduced. In the actual strategy, the return function is estimated only through extrapolation based on the design of experiment. Several procedures of extrapolation are examined in accordance with the sequential programme. If some lack of

definition is introduced, the problem then becomes one involving stochastic decision processes. It seems necessary to distinguish two kinds of indefiniteness in the estimation of the return function, v.z., the indefiniteness of the function itself and that of variables. For both cases functional equations are deduced following the procedure of dynamic programming in stochastic systems.

Afternoon session, April 26 - Chairman: Academician B.N. Petrov (USSR).
Vice-Chairman: H. Chestnut (USA).
Secretary: professor C. Penescu (Roumania)

ON ADAPTIVE PREDICTION

by professor R.E. Kalman (USA)

During the past two years, a new approach was evolved by the author (with R.S. Bucy, J. Basic Engr. 1961 and 1962) to problems of least-squares curve fitting, regression analysis, satellite orbit smoothing calculations, statistical prediction and filtering, etc. These operations are performed by a feedback system in which the element in the forward path is viewed as a model of the stochastic process involved and the feedback gain is inversely proportional to the information contained in the data. Besides being a fundamentally new technique in relation to the classical problems mentioned above, this theory is of central importance in optimal control theory as it supplies estimates of state variables which cannot be measured directly.

The purpose of the paper is to report on new research results concerning the above problems. Specifically, the following topics are treated:

1) Real-time computation of the meansquare error in curve fitting and its use for statistical decision-making.

2) Adaptive estimation of the signal and noise covariance matrix and other statistical parameters by maximum likelihood methods.

3) Adaptive estimation of the information contents of the signal source and automatic adjustment of the feedback in the optimal filter.

4) Discussion of experimental results concerning adaptive filters operating on realistic stochastic processes.

OPTIMAL CONTROL OF MULTIVARIABLE DYNAMIC PROCESSES

by professor J.G. Balchen and Dr. F. Aasma (Norway)

The control law or strategy for optimal control of a multivariable linear process is derived on the basis of a performance criterion of the form

$$I = \int_0^t q\,(\underline{x}, \underline{y})\,dt$$

where I is to be minimized fr maximized. The terms $\underline{x}$ and $\underline{y}$ are independent and dependent process variables (vectors) respectively. If $q\,(\underline{x}, \underline{y})$ is of quadratic form, the strategy turns out to be a linear system which can be achieved as a combination of feedforward and feedback elements. The parameters of this strategy are dependent upon the assumed form of the non-controllable process variables.

A simplified strategy (semidynamically optimal) is introduced which does not depend upon the knowledge of non-controllable variables and dynamic parameters of the process. The performance of this strategy is compared with the exact one by means of a frequency response plot revealing the essential characteristics of both strategies.

HOMEOSTATIC CONTROL OF DYNAMIC SYSTEMS

by Dr. L. Radanovic and professor R. Tomovic (Yugoslavia)

The paper introduces a new approach to the adaptive control of dynamic systems which stems from interesting ideas proposed recently. As is known, the behaviour of a dynamic system

$$x_i = x_i\,(t, q_1, \dots q_n)$$

is not only a function of time but also of a set of parameters,

$$Q = \{q_r\} \quad r = 1, \dots n.$$

If an exact model of the dynamic system is available and if both the model and the physical system are subject to the same disturbance there will always exist a difference

$$Q + \Delta Q = q_r + \Delta q_r$$

between the set of parameters which define the behaviour of the mathematical model and the actual parameters of the real system. Thus, important information about the behaviour of dynamic systems can be derived from the sensitivity coefficients.

$$u\,(t, q_{ro}) = \partial x_i / \partial r.$$

Modern sensitivity analysis of dynamic systems provides methods of machine calculation of these sensitivity coefficients.

The knowledge of sensitivity coefficients then allows for analytical treatment of the influence of Δq_r on the solution

$\Delta x_i = x_i (t, q_1 + \Delta q_1, \ldots q_n + \Delta q_n)$. The paper also considers the inverse problem, i.e. given Δx_i, what is the set of parameter deviations Δq_i that cause the difference in system performance. To solve this inverse problem, a criterion for optimization of system performance must be assumed and the sensitivity coefficients $u (t, q_{ro})$ known. Then the problem can be reduced to the calculation of components of a given vector in functional space.

The knowledge of sensitivity coefficients enables the following important problem to be solved analytically: Given the permitted deviation between the performance of the real dynamic system as compared to the mathematical model, calculate parameter tolerances which can be considered as normal. By applying modern computers it is thus possible to check definitely and in real time whether the set of parameter variations Δq_i is within "normal" limits, i.e., within the specified or permitted deviations in system performance.

Using this approach, the authors propose a new method of performance control of dynamic systems. If, for instance the malfunction of a system is caused by an "abnormal" variation of one or more parameters, one can try to keep the overall performance of the system within specified limits by abruptly changing other, less critical, parameters outside their normal limits. In this way, the adaptive control of dynamic systems approaches the method in which homeostatic systems use discrete variable changes to maintain the overall function.

This is the reason why the term homeostatic is used in the title of the paper. Practical implementation of the problem requires the sensitivity coefficients to be known in parametric space. In other words, in addition to sensitivity coefficients as time variables, $u (t, q_o)$, it is necessary to calculate

$$u (q_r) = (q_r) \, \partial x_i / \partial q_r.$$

Computer methods for this calculation are given as well as theoretical consideration of the feasibility of this approach for homeostatic control of nuclear reactors.

LEARNING MATRICES FOR BINARY AND NON-BINARY SIGNALS

by professor K. S t e i n b u c h (Germany)

The purpose of a learning matrix is to learn a relation between a set of (binary or non-binary) signals and the meaning of this set. By fulfilling this purpose the learning matrix becomes a versatile component of self-adaptive systems. The learning matrix as an electronic device combines "conditioned connections" in such a way that different types of learning processes can be achieved. The conditioned connections at the intersections of the m rows and n columns of the matrix are

subject to simple learning procedures. The set of binary or non-binary signals (a pattern) forms the input to the matrix. The output signals in binary form represent a certain meaning, corresponding to the input pattern being presented to the matrix.

The components of the input patterns are either binary or analog depending on whether the learning matrix deals with binary or analog information. In the former case a particular component takes the value "1" if the corresponding signal is present, otherwise it takes the value "0". In the non-binary case the components take any value between certain limits.

Two modes of operation of a learning matrix can be distinguished:

1) a learning mode during which certain patterns of signals and at the same time the relevant meanings are applied to the matrix in such a way that conditioned connections are built up automatically.

2) a skilled mode during which the meaning of the output of the device is determined by a maximum likelyhood detection system for the pattern of signals applied. In the reverse application, a certain meaning will cause a pattern of the relevant signals as an output.

Accordingly, the following properties of the connecting elements can be postulated:

1) The connecting elements must be usable as storage elements of analog information in a learning matrix for non-binary signals,

2) In a learning matrix with binary inputs the connecting elements must be capable of binary storage,

3) The connecting elements have to be altered during the learning mode,

4) The alteration should be reversible in certain cases.

These requirements are partly met by various passive elements such as certain chemical cells, the resistance of which can be changed by electrical signals. Presently, however, the most versatile elements are magnetic structural devices such as ferromagnetic corse or transfluxors.

The learning matrix appears to be a very useful component in large adaptive systems controlling large-scale processes such as chemical reactions or rolling mills processes, where certain environmental situations are coordinated with reactions of the controlling system.

Morning session, April 27 - Chairman: Dr. J.H. Milsum
(Canada)
Vice-Chairman: Dr. J. Beneš
(Czechoslovakia)
Secretary: Dr. C. Kessler
(Germany)

PROBLEMS OF STABILITY OF ADAPTIVE CONTROL SYSTEMS

by professor R. T a r j a n (Hungary)

The paper is a preliminary report of investigations started recently concerning dynamic properties, especially the stability of adaptive control systems (A-systems). Since the differential equations of A-systems are sufficiently complicated to preclude in most of the cases explicit integration, the only general method of stability investigation is by L i a - p u n o v's direct method. To apply this, however, the important notions of equilibrium and stability of A-systems must be clarified first.

An A-system in the n a r r o w s e n s e is defined as a control system in which the vector p of the internal parameters of an open-loop plant is controlled in a closed loop in response to the changes of the internal or external environments exerting an influence on the output. An A-system in the g e n e r a l s e n s e is one having two closed feedback loops. The main loop operates in the conventional way; the adaptive (secondary) loop operates in parallel with the main loop on the internal parameters p of the main loop so as to improve or to make possible the normal operation of the main loop. The concept of adaptive control can be generalized to that of an n-th order A-system. This is an A-system with n A-loops, such that the K-th order A-loop is controlling directly the internal parameters of the (K-1)-th order loop and through this indirectly all lower order loops, including the main loop. An obvious analogy of the n-th order A-system is that of the organization of the central nervous system.

A first order A-system can be described by a system of two (instead of one) differential equations

$$\dot{X} = f (x, u_o, p)$$
$$\dot{P} = g (p, u, x)$$

where x denotes the vector of the state variable of the main loop and p the vector of the internal parameters of the main loop, which are the state variables of the A-loop. As a consequence, the trajectories, representing the motion of each loop in their respective phase-spaces will depend on the state variable of the other loop as a parameter. The A-system as a whole can be represented as the motion of a point $\left\{\begin{array}{c}X\\P\end{array}\right\}$ = $\left\{\begin{array}{c}x\\x_1 p\end{array}\right\}$ (X, P) in the intersection $\left[\right]$ = $x_1 p$ of the phase-spaces of the two loops.

for all t ≥ t_o. The definition of the equilibrium permits a straightforward generalization of the definition of stability, together with its different modifications, for A-systems. In conclusion, it is conjectured that under suitable conditions the parallels of L i a p u n o v's theorem concerning stability exist; these problems will be investigated in a subsequent paper.

The equilibrium point of the A-system can then be defined as a point $\left\{\begin{array}{c}e\end{array}\right\}$ = $\left\{\begin{array}{c}x_e, p_e\end{array}\right\}$ in $\left[\right]$ where x_e and p_e are the solutions of the two simultaneous equations

$$f (x, p) = 0$$
$$g (x, p) = 0$$

SOME RESEARCH WORK IN SELF-ADAPTIVE SYSTEMS IN THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY AERONAUTICAL
AND ASTRONAUTICAL ENGINEERING DEPARTMENT

by professor Y.T. L i and Dr. P. W h i t a k e r (USA)

Adaptive control may be classified according to the type of desired system performance. For dynamic response one form of desirable adaptability is describable by the system's transient response to a step input. Work along this line has been conducted using the model reference technique. An early approach involves the search of a set of optimum settings of the compensating parameters to minimize a performance index in the form of the weighted integral difference between the system output and the output of an analogue model. The model has a fixed desirable dynamic characteristic. In operation, both the system and the model are subjected to similar test step inputs. Some test results of this type of system in operation are discussed.

In a later version a computer is introduced to convert the performance index of the system into a r a t e o f t h e c h a n g e of the performance index with respect to the adjustment of the compensating parameters. The desired operating condition for the system is defined as when this rate of change of the performance index is zero. In this modified model-reference adaptive system a nulling controller is used instead of an optimalizing controller to make the adjustment of the compensation parameters. For this reason searching action is eliminated and a faster system is therefore achieved.

Another technique for describing the adaptibility of system dynamic characteristics utilizes the frequency response method. Work along this line centers around the use of amplitude and frequency-sensitive elements to make the adjustment of the compensating control adaptive system. Analysis of the degree of adaptability as well as the design method for this type of adaptive systems are discussed.

ON THE APPLICATION OF ADAPTIVE SYSTEMS TO THE AUTOMATION OF THE DESIGN OF CONTROL SYSTEMS

by professor V.K. C h i c h i n a d z e and Dr. O.A. C h a r k-
v i a n i (USSR) translated into English by Dr. J. Beneš

The paper deals with the problem of applying adaptive systems to automatic synthetizing processes in control systems satisfying certain requirements. An adaptive system has an extremely redundant structure the entropy of which tends to be a maximum. Another characteristic feature of the system is that there is no algorithm for the operation of the system and searching is a random process. An adaptive system of this kind can find relative optimal indexes of the complex process-system irrespective whether the optimization function is continuous or discontinuous and irrespective of the number of extremal points. The adaptive system can also find an absolute maximum (minimum). However, the probability of obtaining the latter is small.

Due to the memory unit incorporated in the system this probability can be appreciably increased. Therefore in order to achieve the synthesis of the system it is necessary to know only those characteristics which the process and the control system must have when operating jointly. As in an initial period of its operation an adaptive system possesses almost no information at all, its operation is appreciably different from the directed search systems.

The synthesis of various control systems usually depends on the fulfillment of certain given conditions which are determined by the required dynamic characteristics of the process. These characteristics may include a periodicity and monotony of transient processes, process control time, frequency and amplitude of self-oscillations, etc.

As it is known, the process of synthesis of a system can be conditionally divided in two stages. The first stage consists in determining the structure and parameters of automatic control devices. The second stage is the construction of the system synthetized in the first stage. As a result, the structural diagram yields a schematic diagram.

The first part of the paper deals with the automation of the synthesis of systems carried out using an electronic model of an adaptive system designed in the Institute of Electronics, Automation and Telemechanics of the Georgian Academy of Sciences.

The problems of automation in synthesizing the plant equation or a certain portion of the system were solved using an analogue model. The analogue is supplemented with the electronic model of an adaptive system. After the model receives information on the output of the controlled plant, it rearranges its structure and parameters until the output value or any other manipulated variable satisfy the preset dynamic requirements. The output of the electronic model is summed with the plant input. Thus, a closed loop: plant - adaptive system - plant is achieved.

The first part of the paper illustrates particular instances of the synthesis of control systems designed for plants described by linear differential equations. The results obtained are compared with those obtained by calculating control systems designed for the same plants, these being performed by skilled personnel with the assistance of well-known frequency techniques.

In the second part the authors consider examples of the mechanical synthesis of control systems to be used in plants described by non-linear equations. They also give the transfer functions of these control systems which were determined by the adaptive system using search procedures.

Afternoon session, April 27: Chairman: Mr. M. P é l é g r i n
(France)

Vice-Chairman: Dr. A. S t r a s-
z a k (Poland)

Secretary: Dr. R. O l d e n -
b o u r g (Germany)

ANALYSIS OF OPTIMIZING CONTROL SYSTEMS USING FUNDAMENTAL ADAPTATION CONCEPTS

by Dr. L. P u n (Switzerland)

Many expressions are used to describe recent advanced automatic operations: prediction, extrapolation, optimization, adaptation, learning etc. Confusion often arises on the significance of these expressions. There is a need for a consistent set of expressions and symbols to elucidate certain control systems and also to permit suggestions for new avenues of research.

The paper attempts to formulate such a set of expressions and symbols. It is found that the basic structure of an automatic control system is an adaptive structure and that optimization qualifies various degrees of adaptation. Therefore, every complex automatic control system can be analysed using this point of view.

The paper has two parts. In part I, the basic concepts of an automatic adaptive system are first discussed. To design such a system it is necessary to define clearly:

a) fundamental automatic operators: identifier, computer and actuator;

b) fundamental adaptation guides: objective, performance index and computing policy.

The idea of optimization can be introduced easily by using these fundamental concepts. Optimization exists whenever better automatic operators are used, or more adequate adaptation guides are adopted. Optimization corresponds therefore to an idea of degree of adaptation. Symbolisms are thus necessary to re-

present the adaptation and its various degrees. Successively canonical forms, serial and parallel combinations, and a general classification of adaptive structures are examined. In part II, the following controls are analyzed:

- Prediction control
- Learning model
- Minimization in the sense of Wiener-Hopf
- Corbin's method: one parameter adjusting optimization
- Gibson's method: two parameter gradient policy optimization;
- Invariant control in a thermal plant multi-loop control;
- Kirchmayer's economic optimal static dispatching.

ON THE PRINCIPLES OF DESIGN OF SOME KINDS OF ADAPTIVE CONTROL SYSTEMS
by professor G.S. Pospelov (USSR), translated into English by professor V. Broida.

The author considers single-action automatic control systems, the behaviour of which is essential in the interval $0 < t < t_1$ and not important in the interval $t_1 < t < \infty$. When information on disturbances and parameters of the process is insufficient, it is necessary to design an adaptive system.

In the paper there are two possible ways of designing a single-action adaptive control systems, based respectively on continuous and on discrete control. With discrete control the aim is achieved by a developed method of numerical integration of differential equations.

The author introduces the concept of control resources and of their optimal division into two parts. The first part permits the achievement of optimum control, defined by variational calculus, Pontriagin's or Bellman's methods. The second part is intended to compensate disturbances and to preclude results of variations and of the influence of process parameter fluctuations.

APPLICATION OF ADAPTIVE FLIGHT CONTROL
by Dr. D.L. Mellen (USA)

The paper is a sequel entitled "Adaptive Flight Control" delivered by O.H. Shuck at the First International Congress of IFAC in Moscow, 1960. The adaptive concepts presented by Shuck have been developed further by a combination of theoretical study, simulation and flight test. The resulting adaptive concept as it is applied to automatic flight control is described. In particular, the results of the development flight tests of the MH-90X adaptive flight control system in the supersonic F101A air plane are reviewed. The paper concludes with a discussion of the problems of adaptive system operation when faced with control system thresholds and rapid command inputs.

The adaptive flight control system developed for and recently flight tested in the X-15 aero/space vehicle is described. This system includes several unique features based upon the adaptive concept such as automatic blending of aerodynamic and reaction controls and redundant mechanization to obtain extremely high reliability.

FOLLOW-UP CHARACTERISTICS OF OPTIMALIZING CONTROL SYSTEMS USING DEVIATION TRANSPOSE DETECTION
by Dr. B. Kondo and Dr. T. Suzuki (Japan)

The system described is a kind of optimalizing control system in which the partial derivatives of system output with each input are measured by superimposing small rectangular sensing signals on the inputs. From these values the amount of deviation of each input from its optimum value is calculated and each input is readjusted to its optimum value. In the ideal case where the static characteristics of the system are parabolic and invariant for arbitrary shifting of the optimum point, (if the dynamics of the system are ignored), the system can be designed so that it is completely settled in the optimum condition after only one test cycle. In general, however, with successive repetition of the above-mentioned procedure, each input approaches its optimum value.

In the paper, the system with a single input variable is discussed first. In this case, the system stability, the settling-time and the follow-up characteristics, when the optimum point is abruptly shifted, (which include the dynamic effects of the linear input element) are considered. Next, for the system with two input variables, the relation between the settling-time and the interactions of input variables is obtained quantitatively, and the gains of optimalizing loops necessary to make the settling-time a minimum are obtained by the root locus method in Z-transforms.

However, it is shown that the most effective method for decreasing the settling-time is to remove the interactions between input variables. For this purpose some procedures are proposed and compared from the viewpoint of settling-time. Finally, a brief discussion on the integrating type of optimalizing systems with sinusoidal sensing signals is also given.

The results described in this paper hold, strictly speaking, only for the particular systems described. However, the follow-up characteristics of any other optimalizing system which uses a trial and error method can be easily and at least qualitatively evaluated by analogy with the results given.

Morning session, April 28: Chairman: Professor V. B r o i d a
(France)
Vice-Chairman: Dr. J. A s e l -
t i n e (USA)
Secretary: Dr. J.H. W e s t c o t t
(UK)

PHYSICAL AND LINGUISTIC EVOLUTION IN SELF-ORGANISING SYSTEMS

by Dr. Gordon P a s k (UK)

(1) The author reiterates the distinction, made by A s h -
b y, between systems and physical objects, such as a network
of neuron-like elements or any other simulator of brain acti-
vity. For the present discussion a self-organising system is
an information structure which develops within such an assem-
bly. The author considers this process from the viewpoint of
a complete analogy (probably first pointed out by J.W.S.
P r i n g l e) between the evolution of such a self-organiz-
ing system, which is otherwise called "learning" and the
natural evolution of a species of organism.

(2) According to this analogy, the brainlike assembly is an
internal environment isomorphic with the natural environment
of an evolving species of organism. The author considers the
interaction between modes of activity in a self-organising
system and the internal environment in which the system is
developing (this relation is isomorphic with the interaction
between the behaviour of an organism and its habitat), which
may, of course, include a group of similar organisms). There
are a couple of points of special interest:

a) In natural evolution there is a discontinuity at the stage
where members of the evolving species become capable of
appreciably modifying their surroundings. At this stage the
evolution of the species become autocatalytic. A comparable
discontinuity occurs in "learning".

b) The stability of macro-organisations amongst members of a
species of organism depends upon the development of language
systems which amongst other things, permit communication
between different generations. Once again there is an ana-
logous process amongst the evolving self-organising systems
which mediate learning in the assembly. At this level, how-
ever, the process is "concept" learning and implies the deve-
lopment of an hierarchical information structure in which the
different levels are characterized by metalanguages of in-
creasing order. In either case (species of organism or the
self-organising systems) the linguistic structure is needed
in order to maintain stability in an increasingly elaborate
structure, and, in this sense, is a consequence of the basic
evolutionary process.

(3) A significant feature of this field of study is that the
same informational pattern is repeated at many different levels.
Thus the author has argued that evolution (in the present, or-
ganisational, sense) is a process that occurs amongst informa-

tion structure in brains or networks and amongst organisms in
the real world. Equally, of course, it occurs at an intermediate
level in the development of the individual organism and, in
particular, the maturation of its brain. Further, there is
interaction between these differently embodied evolutionary
processes. Learning occurs, in physical fact, in the internal
environment provided by the brain of some organism. The learn-
ing process determines the organisms behaviour, which in turn,
places organisms with certain forms of brain at a selective
advantage. Similarly, the Genetic constraints of the success-
ful variants modify the interactions which occur in the course
of maturation.

At a purely descriptive level, this repetitious macrostructure
helps to reconcile the position adopted on the one hand, by
exponents of random networks such as Rosenblat's Perceptron,
and, on the other hand, by neurophysiologists such as Sperry,
and students of artificial intelligence such as Minsky and
Selfridge, for it indicates where we should look for the con-
straints in a real brain, and where we should build order
rather than randomness into a brain simulator.

(4) However, this macrostructure appears to have more profound
implications which have not yet been adequately considered.
Briefly, if a subsystem evolves that is capable of interpret-
ing messages in its environment, the existence of this kind
of macrostructure guarantees unlimited extension.

(5) The author illustrates this point, with reference to bio-
logical memory in such a system, arguing:

a) that because a brain is a physical system that is closely
coupled to an organism and its environment, the occurence
of any real event will necessarily be represented by an in-
definite number of different kinds of adaptation (such as
molecular changes, biochemical changes and changes in neu-
ral activity).

b) It can be shown that a self-organizing system is at any
moment capable of interpreting some memories, or some re-
presentations, of this event (that is, it will behave as an
abstractive filter with these representations as its input).

c) In particular, such a mechanism can evolve within the brain
itself. Indeed, this is the argument of (2) and (3).

d) the author argues that "memory" is a matter of "coding"
rather than capacity. If the evolutionary system develops
indefinitely as in (3) and (2) an increasing number of dif-
ferent physical representations of any previous occurence
will become intelligible to it.

6) Discussion of evidence for biological plausibility of this
cybernetic hypothesis.

7) Discussion of the realisation of such a mechanism in dif-
ferent fabrics and its relevance to devices such as J.D.
C r a n e's Neuristor networks and some assemblies developed
at v o n F o e r s t e r's department.

(8) The first part of this discussion bearing upon the basic evolutionary concept is illustrated by a model that has been programmed, and some experiments are described.

A STATISTICAL THEORY OF SYSTEM ADAPTATION BY FEEDBACK

by professor R. F. Drenick (USA)

A statistical formulation is given of a general control problem. In this formulation, a plant, which may be perturbed by environmental effects and noise, is required to generate an output which differs as little as possible on the average from an input. It is desired to supplement the plant with auxiliary devices which compensate for the disturbances and achieve the best possible performance. In the paper, it is first pointed out that the control problem thus formulated differs from the central problem of information theory only in the constraints which are imposed on the choise of these auxiliary devices. A particular set of constraints leads to a rather general form of linear or nonlinear feedback control. Conditions are given under which optimum feedback loops exist. A criterion is suggested under which such loops might be properly called (-) adaptation loops and conditions are advanced which ensure that the loops have the requisite property.

ADAPTIVE INFORMATION PROCESSING

by professor Sheldon S. Chang (USA)

The papers describes a computer program for interpolation, integration and differentiation of a function f(x) which is unknown except at sampling points. The program yields automatically the formula to be used so that the processed result is the most likely one amongst all possible ones. The expected error is also given.

The program is based on the statistical decision theory with the assumption that f(x) has a power spectrum which may or may not be known. In the special case that there is no error at sampling points and the power spectrum is band-limited, the general formula for interpolation is reduced to a cardinal data hold, and the general expression for expected error is reduced to a statement of Shanon's sampling theorem.

ADAPTIVE FEATURES OF AN INVENTORY CONTROL PROCESS

by Harold Chestnut (USA)

The paper relates to an example of stock inventory control in a manufacturing plant. Although the corresponding system was designed by individuals who had no particular automatic control training, this system contains a number of adaptive control features which contribute to its effectiveness.

The inventory control system described in the paper has roughly the following features:

(1) Orders received may come in at any time but they are serviced only at regular time intervals t_1, $t_2 \dots t_n$ and are thus transformed into discrete order requests.

(2) A shipping policy element receives these order requests, as well as the difference (stock at the moment t_n - order requests) and determines roughly the orders to be actually shipped.

(3) A stock policy element receives the difference (stock at the moment t_n - orders actually shipped). It determines, according to stored logic rules:
- the way in which obsolete stock is removed from shipping and eventual stock removal.
- the actual stock at the moment, t_n, after shipping and eventual stock removal.

(4) A computation element - storing logic rules - receives (just as the shipping policy element (2) the difference (stock at the moment t_n, before shipping and eventual stock removal -t_n, order requests). It computes a smoothing factor and determines whether the latter has to take normal "running" values or in case of emergency - "panic" values.

(5) Actual order requests are, therefore, properly smoothed according to this required smoothing policy.

(6) The smoothed statistical data thus obtained is used as a basis for predicting an estimate of stock required at the moment $t_n + 1$, when the next set of order requests will be issued.

(7) This estimated stock at the moment $t_n + 1$ is compared with the stock at the moment t_n (before shipping and eventual stock removal) in an order policy element which is also influenced by a safety factor. This order policy element determines, therefore, the requested stock increment $t_n + 1 - t_n$.

(8) A lead time element (probability of receiving actually the requested stock increment) transforms this requested stock increment into stock expected to be actually received during the time period $t_n + 1 - t_n$.

(9) The addition of this stock expected to be received during the time period $t_n + 1 - t_n$ to the stock actually received during the time period t_n.

e x i s t i n g at the moment t', a f t e r shipping and eventual stock removal (yielded by the stock policy element (3)) gives the statistical stock at the moment t_{n+1}. This information is then used, for the next time period, as a partial input in elements (2), (3), (4), and (7) and so on.

The paper gives detailed block diagrams of the system outlined above and stresses its adaptive control features.

CLOSING REMARKS ON THE SYMPOSIUM IN ROME

Closing speeches were held by academician B.N. P e t r o v (USSR), Chairman of the IFAC Committee on Theory, by professor Ed. G e r e c k e (Switzerland), President of IFAC, and by professor A. M a r i n o (Italy).

All papers were followed by very lively discussions in which the majority of the 65 participants of this Symposium took part. The participants from 17 countries were invited by the IFAC Technical Committee on Theory and the Commissione Italiana per l'automazione. This Symposium was voted a great success.

The Proceedings of the Symposium will be published both in English and in Russian versions in autumn 1962 by the Instrument Society of America (as a special issue of its Transactions on Automatic Control) and by the Institute of Automatics and Telemechanics of the USSR Academy of Sciences respectively.

NEWS FROM NATIONAL MEMBERS

Roumania

Recently new elections have taken place in order to nominate the members of the Commission of Automation of the R.P.R. Academy of Sciences. The Commission is one of the founder members of IFAC. The activity of the Commission covers the following areas:

- scientific coordination of automation research. Initiating and organizing studies and inquiries in new fields of automation,

- recommendations connected with the development of industrial automatization in the Roumanian People's Republic,

- organization of scientific events on these problems (sessions, conferences, lectures),

- initiating and directing measures to be adopted to raise the level of qualification amongst specialists in automation,

- studies of terminology, standardization etc. concerning automation.

The president of the Commission is Academician Gr. C. M o i s i l , member of the Executive Council of IFAC; the scientific secretary is Mr. I. P a p a d a c h e , head of the Section of Automatics and Telemechanics of the Institute of Electro-technical Research.

The address of the Commission is: R.P.R. Academy, Commission of Automation, Calea Victoriei 125, Bucarest.

USA

Errata:

We published, in Bulletin no. 12 (page 5), a list of officers, delegates, alternates and Committee Chairmen of the American Automatic Control Council with an error for which we apologize. The name of the delegate of the A.I.E.E. (American Institute of Electrical Engineers) is Louis F. K a z d a and not Rowland G. L e x , Jr.

WORLDWIDE AUTOMATIC CONTROL

International Events

IMEKO

Two International Measurement Conferences were held in 1958 and in 1961 in Budapest (see Bulletins no. 8, pp. 67-68, no. 9, pp. 8-9, no. 10, pp. 18-19 and no. 11 pp. 14-16). The Permanent International Preparatory Committee of the IMEKO Conferences held a 4 day session on the 2nd March, 1962 in Budapest. Its task was to adopt scientific principles and to take the first organizational steps for the third IMEKO Conference to be held in 1964. Thirty scientists and specialists from 16 countries, 13 of them officially representing technical societies, took part in the Session.

The International Preparatory Committee accepted British, Japanese and Italian Societies as new members increasing the number of Member Organizations to 13.

The Committee accepted the invitation of the Swedish Member Organization (The Royal Swedish Academy of Engineering Sciences) to arrange the next International Measurement Conference in Stockholm in April 1964. It was agreed, that IMEKO 1964 be organized jointly with the traditional Swedish I and M Conference.

After analysing the returns of questionnaires issued to IMEKO 1961 participants, the Committee laid down detailed principles for its future work. It was decided, that the scientific programme would include approximately 120 lectures from all important fields of measurement.

Delegates were presented by their host, the Hungarian Scientific Society for Measurement and Automation, with the newly published 5 volumes of ACTA IMEKO 1961, which will become available in the near future (see our note under "Publications").

INTERNATIONAL SYMPOSIUM ON THE APPLICATION OF AUTOMATIC CONTROL IN PROSTHETICS DESIGN

As already announced in our Bulletin No. 12 (page 9), this Symposium, which is being organized by the Yugoslav Committee for Electronics and Automation, will take place in Opatija from 27 August to 1 September, 1962.

To date the following papers have been definitely accepted for presentation:

(1) H. G r o t h and J. L y m a n (Biotechnology Laboratory, University of California, Los Angeles, USA): Electrical and Mechanical Properties of New Body Control Sites for Externally Powered Arm Prostheses.

(2) H. G r o t h and J. L y m a n: Practical Transducer Problems for Electro-Mechanical Control of Prostheses.

(3) A. N i g h t i n g a l e (Physics Laboratory, St. Thomas' Hospital, London): Myo-Electric Control of Artificial Muscles.

(4) R. T o m o v i c (University of Belgrade and Institute for Electronics and Automation "Mihajlo PUPIN", Belgrade): The Role of Automatic Control in Prosthetics.

(5) M. R a k i c (University of Belgrade and Institute for Electronics and Automation "Mihajlo PUPIN", Belgrade): Design of a Hand Prosthesis with Automatic Control.

(6) B. Z o t o v i c (Institute for Orthopaedic Prosthetics, Belgrade): Medical Aspects of a Hand Prosthesis with Automatic Control.

(7) S. B a r a b a s c h i (Nuclear Research Center, Casaccia, Italy): Remote Handling Problems in Nuclear Plants and Laboratories.

(8) S. B a r a b a s c h i, S. C a m m a r a t a, C. M a n c i n i, A. P u l a c c i, F. R o n c a g - l i a (Nuclear Research Center, Casaccia, Italy): An Electronically Controlled Servo-Manipulator.

Final titles are still awaited from:

- K o b r i n s k i i, Institute for Theory of Machines, Moscow.
- J. R e s w i c k, Director, Engineering Design Center, Case Institute of Technology, USA.
- L. G i l l i s, Queen Mary's Hospital, England.

The discussion will cover engineering, medical and application aspects of the introductory papers. The working languages will be English and Russian.

All correspondence concerning the Symposium should be addressed to

Yugoslav Committee for E T A N
Terazije 23, Belgrade, Yugoslavia.

Austria

The following lectures have been given in Vienna under the auspices of the O.A.A. (Oesterreichischer Arbeitsausschuß für Automatisierung - Austrian Committee for Automatization):

On March 15, 1962 - "Economical and technical considerations for punched-tape control of machine-tools": by R. Stuetzel.

On April 5, 1962 - "The progress of life sciences as a technical problem" by W. Wieser.

On May 17, 1962 - "Some automatization trends in the USSR" by W. Frank and F. Margulies

Canada

SEMINAR ON CONTROL THEORY

A summer seminar on Control Theory is to be held at McGill University, Montreal, in September, 1962. The theme of the seminar is Optimal Control Systems and the keynote address entitled "Applicability of New Theories" is to be given by Dr. J. Ham, Chairman of the National Research Council Associate Committee on Automatic Control. Papers are to be presented on such topics as the phase-space concept, multivariability, hill climbing and computer control. The seminar will terminate with a panel session, devoted to the control problems of the practising engineer.

France

SYMPOSIUM ON MODERN COMPUTING TECHNIQUES AND INDUSTRIAL AUTOMATIC CONTROL

We have already announced in Bulletin No. 11 (page 20) this Symposium held since in Paris on May 28-30, 1962.

Amongst the papers read at this Symposium we list the following:

Brue, Megy, Dive, Pupponi : Utilisation de calculateurs dans les centrales nucléaires; premiers resultats et perspectives d'avenir. (Use of computers in nuclear power stations; first results and future prospects).

Ambrosini, Cipollina, Mathis : Automatic Control of an organic-moderated prototype nuclear power plant.

Grunberger, Theodore : Conduite automatique d'une centrale thermique par calculateur numérique industriel (Thermal power station digital computer control).

Lebel, Bouchard : La régulation fonctionnelle multiplexée: application à la régulation d'un générateur de vapeur de centrale thermique (Multiplex functional control: application to the thermal power station steam generator control).

Cassagne : Les calculateurs analogiques à courant continu à échelle de temps réel inclus dans des boucles de régulation et de contrôle (On-line direct-current real-time analog computers).

Auricoste : Application de calculateurs numériques spécialisés à la commande numérique de machines-outils; utilisation de centres de calcul pour la préparation des programmes (Application of specialized digital computers to machine-tool digital control; utilisation of computation centres for programme preparation).

Cariou : Présentation d'un langage symbolique AUTO-PROMPT facilitant la préparation des ordres d'usinage sur les machines-outils à commande numérique (Presentation of an AUTOPROMPT symbolic language facilitating machining order preparation on digitally-controlled machine-tools).

Csech : Quelques problèmes de calcul rencontres dans l'automatisation de machines-outils (Some computing problems in machine-tool automatization).

Bernard, Deleglise : Le rôle et l'utilisation des calculateurs dans l'automatisation des unités sidérurgiques (The role and use of computers in steelwork automatization).

Versini : Quelques applications du calcul analogique et du calcul numérique dans l'étude et la réalisation des systèmes de conduite de processus industriels (Some analog and digital computing applications in industrial process control design and achievement).

Carpentier, Siroux : Optimalisation de la production d'énergie électrique à l'aide d'un calculateur numérique; problèmes theoriques et implantation d'un calculateur au "dispatching" national de l'E.D.F. (Electric power production optimization by digital computer; theoretical problems and introduction of a computer into the Electricité de France national dispatching).

Delafontaine : Note sur la régulation intrinsèque (Note on intrinsic control).

Lermoyez : Programme généralisé d'optimalisation de processus industriel à l'aide d'un ordinateur; application à

une unité de fabrication d'éthylène (Generalized programme of industrial process optimization by computer; application to an ethylene production unit).

U f f l e r : Les applications des procédés de calcul ANALAC au calcul universel et à la commande automatique (ANALAC computing method applications to universal computation and automatic control).

H o n o r é : Le traitement des problèmes d'optimalisation par les procédés de calcul ANALAC (Optimizing problem processing by ANALAC computing methods).

B o u r g e t : Optimalisation de la conduite des processus de raffinage au moyen de calculatrices numériques électroniques et d'appareils d'analyse en continu; étude de rentabilité (Refining process control optimization by electronic digital computers and stream analyzers; cost investigation).

B o s s e t : Utilisation des calculateurs numériques en contrôle économique; méthodes de calcul et applications (Digital computer utilization in economical supervision; computing methods and applications).

Mrs. G a u d f e r n a u : Le calcul automatique utilisé pour le contrôle des équipements automatiques de réduction de données (Automatic computing used for checking automatic data reduction equipment).

P r a d e s : La notion de logique enregistrée; son emploi dans la réalisation de calculateurs numériques industriels (The notion of recorded logics; its use in designing industrial digital computers).

M a s o n : Applications of the UNE, a hybrid computer element.

M a r r e t : Description et rôle de l'interruption de programme dans les calculateurs d'automatisme (Description and role of programme interrupt in control computers).

C a r r i e r , B a u d e l a i r e : Applications des calculateurs numériques au contrôle automatique de qualité et à la papeterie (Digital computer applications to quality control and to paper mills).

Details on the availability of these papers can be obtained from A.F.R.A., 19, Rue Blanche, Paris 9e.

Germany

V.D.I. ANNUAL ENGINEERING MEETING 1962

The VEREIN DEUTSCHER INGENIEURE (V.D.I.) has held its bi-annual Meeting 1962 on May 24-26 at Karlsruhe. The following papers in the field of Automatic Control and especially of the representation by signal flow diagrams were read:

E. K r o c h m a n n : Grundlagen und Möglichkeiten der Darstellung der Struktur von Vorgängen in Signalflussbildern (Fundamentals and possibilities of representing operation structures in signal flow diagrams).

R. O e t t k e r : Das Strukturbild aus der Regelungstechnik als Arbeitsmittel des Ingenieurs (The Automatic Control Structure diagram as a working means for engineers).

W. G i l o i : Strukturbilder von Automobil-Federungssystemen und ihre Behandlung am Analogrechner (mit Vorführung am Analogrechner) (Structure diagrams of motor-car suspension systems and their processing on analog computers).

Ed. G e r e c k e : Signalflussbilder im Hochschulunterricht (Signal flow diagrams in Technical University teaching).

K. P e u s t e r : Darstellung des Verhaltens von Kernreaktoren mit Hilfe von Signalflussbildern (Representation of nuclear reactor behaviour by means of signal flow diagrams).

G. V a f i a d i s : Aufbau und Deutung des Signalflussbildes (Construction and Interpretation of signal flow diagrams).

These papers amongst others will be published in the VDI-Zeitschrift.

Italy

ITALIAN CONGRESS ON INSTRUMENTATION AND AUTOMATION

November 1962

Under the auspices of the Italian National Research Council this Congress will be held in the premises of the Milan Trade Fair from November 22nd to 27th, 1962.

Papers will be presented on the theory and applications of automation and instrumentation in the nuclear, mechanical, electro-technical, chemical and metallurgical industries; automatic data processing and information handling will also be discussed. Papers are invited, which must be received before 31st August, 1962. The Congress fee is 5,000 It. Lire, authors exempt. Further information may be obtained from Dr. Antonio B a r b i e r i , Via Marcona, 15, Milan, Italy.

Roumania

In November 1961, a Scientific Session of REPORTS ON PROBLEMS OF AUTOMATION 1961 was held in Bucarest. It was organized by the Commission of Automation of the R.P.R. Academy.

In the course of the opening session the following papers have been presented:

T. Popoviciu : The Conservation of the rate of convexity of a function, through interpolation.

E. Balaş and L.P. Ivanescu : Problems of transport with nonhomogeneous production.

V. Toma : Comparative study of electronic devices CIFA 1, CIFA 2 and CIFA 3.

C. Penescu : Remarks on Complex Automation of energy systems.

I. Livovski : Determination of the minimum number of states of a finite automaton.

S. Schachter, R. Valent, N. Costake : Remarks regarding the adoption of unified systems for industrial automatic control in R.P.R.

H. Herscovici, M. Calusita, W. Wroisman, L. Nica, I. Marcut : Electropneumatic unified system for automatic control of industrial processes.

G. Weinrich, I. Mihailescu, C. Negoita, I.D. Landau : Constructive achievement of transistorized blocks in the unified system of control of electric actions.

M. Duma, M. Steiner, D. Negreanu, L. Vilkov, C. Binca, M. Dumitrescu, V. Neagu : Complex telemechanical system for objects scattered at small distances, with application to derricks in oil pumping.

REPORTS ON PROBLEMS OF AUTOMATION 1962

The Commission of Automation of the R.P.R. Academy is organizing for the 4-6th October 1962 the next annual session of reports concerning automation. Amongst the topics to be covered are automatic linear and non-linear systems, the problems of finite automatons, adaptive systems, analog and digital computers, technical cybernetics, mathematical linguistics, telemechanics etc. ..... A presentation of economical problems concerning automation is also planned. On applications the papers will refer to components of automatic systems and to special industrial applications.

Further information may be obtained from the Commission of Automation, R.P.R. Academy, Bucarest, Calea Victoriei 125.

Switzerland

13TH SYMPOSIUM OF ASSPA

The 13th Symposium of the Swiss Association for Automatic Control (Association Suisse pour l'Automatique) will be held in Basle on October 17-19, 1962. The two first days will be devoted to the general topic:

Electronic methods of automatic and digital measurements for weighing, counting, proportioning, checking and their application in chemistry,

with the following papers:

Ed. Gerecke : Die Begriffe der Automatik in Anwendung auf die Messvorgänge (The definitions of Automatic Control applied to measuring operations).

O. Winkler : Stand der Anwendung der elektrischen Meßtechnik in der chemischen Industrie (Status of the use of electro measuring techniques in the chemical industry).

Emanuel : Automatisches, elektronisches Wägen und Dosieren (Automatic electronic weighing and proportioning).

E. Grunder : Automatische Waagen (Automatic scales).

Metzger : Digitale Erfassung von Messwerten (Digital processing of measured values).

F. Raufenbarth : Einheitsstromsystem - Rechenschaltungen in der chemischen Industrie, ihre Methoden und Geräte (Standardized current system. Computing circuits in the chemical industry, their methods and devices).

Sanner : Mengen- und Durchflußmessungen in der Chemie (Quantity and flow measurements in chemistry).

C. v. Hasel : Mess- und Regelgeräte für mechanische Grössen (Measuring and control devices for mechanical variables).

R. Zaugger : Viskositätsmessung und -regelung in der Industrie (Viscosity measurement and control in the industry).

Müller-Barbieri: Messung und Regelung der Feuchtigkeit und des Flächengewichtes von Papier (Measurement and control of paper moisture and weight per surface unity).

R.G. Bischof: Automatische Steuerungen mit Lochkarten für Mischprozesse im Chargenverfahren (Automatic Controls for blending processes in lading operations).

H. Engelhardt: Neuere Methoden der automatischen Gasanalyse (Modern methods of automatic gas analysis).

The third day will be devoted to:

Higher Operations in Automatic Control

with the following papers:

Ed. Gerecke: Introduction

M. Hamza: The chronological development of optimum and selfadjusting systems.

D. Lips: Uebersicht über die Optimierung von Regelungssystemen (Review of control system optimization).

L. Pun: Analyse des systèmes de commandes optimalisants à l'aide de conceptes fondamentaux de l'adaptation (Analysis of optimizing control systems by fundamental adaptive concepts).

S. Mitter: Quantifizierte Abtastsysteme für Regelungen mit Digitalrechnern (Quantized sampled systems for digital computer control).

U.A. Corti: Uebersicht über die Probleme der Bionik (Biologie und Elektronik) (Review of bionics-biology and electronics-problems).

SEMINAR ON AUTOMATION IN SMALL AND AVERAGE INDUSTRIES

This seminar was held at Neuchatel on April 24-28, 1962 with the following papers:

R. de Groot; L.J. Perrin: Advantages of automation in small and average industries.

R. de Groot; L.J. Perrin: How to automate at low cost.

A.B. Bloesch: Automation in current life.

R. de Groot: Introduction to the Joint Industry Committee standards.

E. Blasi: Micro-switches.

F. Schäublin: Automatic machines built from standard elements.

F. Flechti: How to install an air pressure network.

The papers will be published in a special issue of the "Bulletin Technique de la Suisse Romande".

ACTIVITIES OF THE GENEVA SECTION OF ASSPA

The lectures provided for 1962-1963 will be devoted to the general topic:

Automatic optimizing methods and means

with the following chapters:

- Principles of automatic adaptive and optimizing methods,
- Analysis methods for the design of adaptive systems,
- Digital methods for processing optimizing problems,
- Industrial examples of optimization applications.

United Kingdom

PRODUCTION EXHIBITION

On the opening day of the Production Exhibition at Olympia on 30th April, the Conference Sessions included a meeting sponsored by B.C.A.C.. W.J. Kease gave a Paper on Date Processing and the Computer in Production Control. This meeting was under the Chairmanship of Sir Walter Puckey, B.C. A.C.'s Chairman.

INSTITUTION OF MINING ENGINEERS

4th July, 1962 at the Manchester College of Science and Technology. W.J. Adcock and B.L. Metcalf: Application of Electronics and Mining.

THE BRITISH INSTITUTION OF RADIO ENGINEERS

16th - 20th April 1963. Convention on Electronics and Productivity at University of Southampton.

USA

THE 1962 JOINT AUTOMATIC CONTROL CONFERENCE

The annual Joint Automatic Control Conference took place on June 27-29, 1962, on the campus of New York University at University Heights, New York City. Societies participating in the Conference were: A.I.E.E., which was responsible for this year's meeting, AIChE, ASME, IRE and ISA. It included a plenary session; 19 technical sessions, workshops, and panel discussions.

A bound volume containing complete copies of all papers presented is available, at a price of $15, from: Mr. R.S. Gardner, Assistant Secretary, Technical Activities, American Institute of Electrical Engineers, 345 East 47th Street, New York 17.

The papers are the following:

- Report of American Automatic Control Council on Status of Control Research in the U.S.A., by J.E. Ward, (Massachusetts Institute of Technology).

Keynote Addresses:

Frontiers of Integrated Automatic Control
- Defense and Industrial Systems by J.R. Moore (University of Illinois).
- Biological Control Systems by Dr. W.R. Ashby (University of Illinois).

Optimum Control 1
- Automatic Optimizing of Poorly Defined Processes, Part 1, by H. Chestnut, R.R. Duersch, W.M. Gaines
- An Application of Functional Analysis to the Optimal Control Problem, by G.M. Kranc, P.E. Sarachik.
- Dynamic Programming: Cumulative Errors in the Evaluation of an Optimal Control Sequence, by J. Guigna-Bodet.
- Hill climbing Methods for the Optimization of Multiparameter Noise Disturbed Systems, by H.J. Kushner (MIT, Lincoln Laboratory).

Nonlinear Systems 1
- A Generalized Mathematical Theory for the Analysis of a certain Class of Nonlinear Time Varying Multiple Loop Feedback Systems, by A.Y. Bilal, L.F. Kazda (University of Michigan).

- On the Application of Zubov Method for Construction of Liapunov's Functions for Nonlinear Autonomous Systems, by G.P. Szego (Purdue University).
- Lagrange Stability of Nonlinear Feedback Systems, by Z.V. Rekasius (Purdue University).
- A Technique for the Synthesis of Linear Nonstationary Feedback Systems. Part 1: The Approximation Problem, by A.R. Stubberud.

Adaptive Control 1
- Multivariable Adaptive Control System, by N.N. Puri (Drexel Institute of Technology), C.N. Weygandt (University of Pennsylvania).
- Use of Generalized Dynamic Model with Adaptation for Optimizing Control of a Continuous Process, by J.W. Bernard, I. Lefkowitz (Case Institute of Technology).
- An Approach to Self-Adaptive Control Based on the Use of Time Moments and a Model Reference, by M.I. Moe, G.J. Murphy (Northwestern University).

Performance Measures 1
- Introductory Talk-Problems of Systems Measurement by J.D. Cowan (Ohio State University).
- Multiloop Control System Study of a Gas Turbine Compressor andPower Unit. Part II: Experimental Investigation, by J.R. Shull, G.A. Russell.
- Application of Multiple Regression Analysis to Measurement of Time-Varying Dynamic Systems, by J.I. Elkind, D. M. Green, E.A. Starr.
- Techniques for Identification of Linear and Linear Time-Varying Processes, by K.A. Bishop, C.M. Sliepcevich (Dept. of Chemical Engineering), T.M. Puckett (Dept. of Electrical Engineering, Oklahoma University).
- An Extension of the Nyquist-Barkhausen Stability Criterion to linear, Lumped-Parameter Systems with Time-Varying Elements, by J.J. Bongiorno, Jr. (Polytechnic Institute of Brooklyn).

Performance Measurements
Panelists:
J. Zaborszky, J.E. Gibson, D.T. McRuer, F.J. Ellert.

Control Computer Availability
Its Need and Implication
Panelists:
T.J. Williams, W. Gaines, Wm. Summers, J.V. Wermes.

Process Dynamics
- Dynamics of Liquid-Solid Fluidized Bed Expansion by Liang-tseng Fan, by J. A. Schmitz, E. N. Miller (Kansas State University).
- Frequency Response of Tubular Flow Systems, by Liang-tseng Fan, Yong-Kee (Kansas State University).
- Transient and Steady State Sized Distributions in Continuous Mixed Suspension Crystallizers, by M. A. Larson, A. D. Randolph (Iowa State University).
- Frequency and Time Domain Approaches to Limit Cycle Amplitude Dynamics, by W. E. Vandervelde (MIT), A. Gelb.

State Space Control Systems 1
- Introduction to State Space Concepts, by L. A. Zadeh (University of California)
- Application of State Space Techniques to Linear Systems, by C. A. Desoer (University of California).
- Problem solving session.

Optimum Control II
- The Optimal Control of Some Attitude Control Systems for Different Performance Criteria by I. Flügge-Lotz, H. Marbach (Stanford University).
- On Some Approximation Techniques in Solving Optimization Problems in Control Systems by M. Aoki (University of California).
- The Dodco Optimal Control System - A Critical Evaluation, by E. G. Rynaski, J. M. Schuler (Cornell Aeronautical Laboratory).
- The Design of Optimum Controllers for Linear Processes with Energy Limitations, by B. Friedland.

Nonlinear Systems II
- A New Dual-Input Describing Function and an Application to the Stability of Forced Nonlinear Systems by J. E. Gibson, R. Sridhar (Purdue University).
- The Frequency Responses and Jump Resonance Phenomena of Nonlinear Feedback Control Systems by H. Hatanaka, (Tohoku University, Japan).
- The Dynamic Input-Output Analysis of Limit Cycling Control Systems, by A. Gelb
- A Technique for the Synthesis of Linear Nonstationary Feedback Systems, Part II: The Synthesis Problem, by A. R. Stubberud.

Process Control
- Design and Control of Feed-Effluent Exchanger-Reactor Systems, by J. M. Douglas, J. C. Orcutt, P. W. Berthiaums.

- Time Optimal Control of a Chemical Reactor, by J. E. Cotter, Y. Takahashi (University of California).
- Dynamic Optimization of a Distillation Column, by R. L. Zahradnik, D. H. Archer, R. R. Rothfus.

State Space Control Systems II
- Analysis of Sampled Data Systems by State Space Techniques, by J. E. Bertram (University of Michigan).
- Optimal Systems by State Space Techniques, by L. F. Kazda (University of Michigan).
- State Space Techniques applied to the Design of Space Navigation System, by S. F. Schmidt.
- Bibliography of State Space Techniques, by T. J. Higgins (University of Wisconsin).

Statistical Methods in Control
- A Method of Producing Multiple Non-Correlated Random Signals from a Single Gaussian Noise Source, by P. I. Boulton (University of Toronto, Canada), R. J. Kavanach.
- Optimal Control of Systems with Generalized Poisson Inputs, by J. J. Florentin (Imperial College, London).
- Error Probability Density for a Class of Nonlinear Control Systems with Random Step Input, by W. N. Wonham, (Purdue University).
- A Simple Iterative Procedure for the Identification of the Unknown Parameters of a Linear Time Varying Discrete System, by H. Kushner (MIT).

Discrete Adaptive Processes 1
- Adaptation and Feedback, by J. Sklansky (Cornell University).
- Self-Organizing Control System by M. D. Mesarovic (Case Institute of Technology)
- Analytic Techniques for the Study of Neural Nets, by F. Rosenblatt (Cornell University).
- Pattern Recognition and Adaptive Control, by B. Widrow, (Stanford University).

Optimization Applications
- Synthesis of Feedback Controls Using Optimization Theory - an Example, by F. J. Ellert, C. W. Merriam
- A Self-Adaptive Control System for the Saturn Booster, by R. K. Smyth, J. C. Davis.
- Control Engineering Applications of V. I. Zubov's Construction Procedure for Lyapunov Functions, by S. G. Margolis, W. G. Vogt (University of Pittsburgh).
- Synthesis of a Minimum Energy Controller Subject to an Average Power Constraint, by A. E. Pearson.

Applications and Components
- Design of Some Active Compensators of Feedback Controls, by R. E. McCamey, G. J. Thaler (US. Naval Post-Graduate School).
- Analysis, Design and Test of a Position Servo Utilizing a Stepper Motor, by J. C. Nicklas (Jet Propulsion Lab. California Institute of Technology).
- Closed Loop Adaptation applied to Missile Control by W. K. Waymeyer.

Sampled Data Systems
- A General Solution for Linear, Sampled-Data Control, by T. L. Gunckel, II, G. F. Franklin (Stanford University).
- On the Equivalence of Discrete Systems in Time-Optimal Control, by E. Polak (University of California).
- The Digital Adaptive Control of a Linear Process Modulated by Random Noise, by C. Pottle (University of Illinois).
- Perturbation Approach to an Adaptive Sampled Data Control System, by Paul Mosner.
- Stability of a Class of Discrete Control Systems Containing Nonlinear-Gain Elements, by S. Kodama.

Discrete Adaptive Processes II
- Some Current Problems in Discrete Models of Learning, by F. Restle (Indiana University).
- Stochastic Learning and a Quantal Model of Signal Detection, by D. A. Norman (University of Pennsylvania).
- Some Current Problems in Models of Learning for a Continuum of Responses, by P. Suppes (Stanford University).
- Adaptive Mechanisms in Digital Concept-Processing, by M. Kochen.

SYMPOSIUM ON THE MATHEMATICAL THEORY OF AUTOMATA

As already announced in our Bulletin No. 12 (page 13) this Symposium was held at the Polytechnic Institute of Brooklyn on April 24-26, 1962. The following papers - to be published as volume XII of the Microwave Research Institute Symposia Series, at a price of $ 7.00, in autumn 1962 - were read:

- Dynamic, Programming, Sequential Machines and Self-Organizing Systems, R. Bellman.
- On the Precise Definition of ALGOL and Other Programming Languages, by J. McCarthy (MIT).
- Unsolvable Problems: A Review, by M. Davis (Yeshiva University).

Computability
- The AEA Case of the Entscheidungsproblem, by H. Wang (Harvard University).
- Degree of Unsolvability and the Rate of Growth of Functions, by S. Tennenbaum (University of Michigan).
- A Simple Source of Non-Computable Functions, by T. Rado (Ohio State University).
- Periodicity of Post's Normal Process of Tag, by S. Watanabe (University of Tokyo, Japan).
- Set-Theoretic Formalizations of Computational Algorithms, Computable Functions, and General-Purpose Computers, by R. E. Levien.

Classes of Automata and theorem Proving
- Abstract Machines: A Generalization of Sequential Machines - Survey, by S. Ginsburg.
- Certain Families of Elementary Automata and Their Decision Problems, by M. P. Schutzenberger (Harvard University).
- A Turing Machine which prints its Own Code Script, by C. Y. Lee.
- Theorem Testing by Computer, by B. Dunham and J. H. North.
- Machine-Generated Problem Solving Graphs, by H. Gelernter.
- Self-Repair as a Computability Concept in Automata Theory, by L. Lofgren (Research Inst. of National Defense, Stockholm, Sweden).

Algebraic Analysis of Automata
- Processors for Infinite Codes of the Shannon-Fano Type, by S. Gorn (University of Pennsylvania).
- Application of Lattice-Ordered Semigroups to Codes and Finite-State Transducers, by A. E. Laemmel (Polytechnic Institute of Brooklyn).
- The Group and Semigroup Associated with Automata, by G. P. Weeg (Michigan State University).
- Structure of Monoids with Applications to Automata, by J. Mezei.
- An Analytical Representation of Signals in Sequential Networks, by T. L. Booth (University of Connecticut).
- Algebraic Theory of Machines, by J. L. Rhodes (MIT).
- An Algebraic Theory of the Analysis and Synthesis of Automata, by T. Sunaga (University of Kyushu, Japan).
- Theory of General Information Networks: An Algebraic and Topological Foundation to the Theory of Information Handling Systems, by M. Iri (University of Kyushu, Japan).

Switching Theory and Networks

- Essential Multiple-Output Prime Implicants, by E. J. Mc Cluskey Jr. and H. Schorr (Princeton University).
- Combinational Elements and Fiducial-State Assignments, by G. W. Patterson and R. McNaughton, (University of Pennsylvania).
- Derivation of Optimum Tests to Detect Faults in Combinational Circuits, by J. F. Poage (Princeton University).
- Canonical Regular Expressions and Minimal State Graphs for Definite Events, by J. A. Brzozowski, (Princeton University).
- The Analysis and Synthesis of Signal Switching Networks, by S. H. Unger.
- Pattern Recognition Using Two-Dimensional, Bilateral, Iterative, Combinational, Switching Circuits, by B. Beizer. (Columbia University).

Search and Convergence

- Some Mechanisms in Hypothesis Selection, by M. Kochen.
- On Convergence Proofs for Perceptrons, by A. Novikoff (Stanford Research Institute).
- The Utilization of Environment Continuity by Self-Organizing Systems, by A.M. Andrew, (National Physical Laboratory, Teddington, England).

A panel discussion on relations between computability and computers was lead by M. Minsky, (MIT).

THE SYSTEMS RESEARCH CENTER OF THE CASE INSTITUTE OF TECHNOLOGY

We have already reported in our Bulletin No. 11 (pages 34-36) on the research work under way in this Systems Research Center. The new issue of "Research Abstracts" dated January 1962 gives the following additional features of this research work: (Topics marked (+) correspond to particular reports available at the Case Institute of Technology, Cleveland, Ohio, USA).

Group A. Adaptive and self-organizing systems
Group Director: Professor M. Mesarovic

New Research Topics
- Analytic techniques for solution of optimum control equations, by R. Archer.
- Reliability of logical nets, by J. Miro (+).
- Methods of nonlinear recognition in cognitive systems, by J. Miro.

A. Gosiewski is presently concerned with the two following topics:
- Compensation of influence of delays in multi-variable discrete Automatic Control Systems (+).
- Influence of "checking frequency" on adaptive action.

On the other hand, the disappearance of some previously mentioned topics is compensated by the addition of the following new topics:

Topics cited previously	Topics added
- Interactions in multi-variable systems, by P.A. Orner.	- Measure of interaction strength, by I. G. Birta (+).
- Systems approach to complex societies, by E.S. Uyeki	- General systems approach to organization theory, by J. L. Sanders (+).

Group C. Control of complex systems
Group Director: Dr. I. Lefkowitz

New research topics:
- Maximum principle applied to feedback control, by J.D. Schoeffler.
- Dynamic programming adaptation technique, by J. H. Burghart and J.D. Schoeffler.
- Model Adaptation of time-varying multi-variable systems, by G. J. Coviello.
- Computer optimizing and adaptive control of multiple-unit heat exchange system, by W. D. McLeod and A.A. Schoenberg.
- Application of computer control to a continuous strip process, by P. R. Sullivan.
- Feasibility study of "first level" digital control computer, by R. W. van Pelt and R. C. Durbeck.
- Economic study of computer control, by Y. Kuratani.
- Economic analysis of computer control, by W. A. Greaney and Ph. A. Lambert.
- Modeling of process systems, by R. J. Adler.
- Simplified determination of residence-time distributions, by J. W. Rooze.
- Effect of mixing in chemical reactor performance by H. Weinstein.

W.L. Gilliam is concerned with the topic:
- General study of direct-type optimizing controllers.

On the other hand, the disappearance of some earlier topics is compensated by the addition of the following new subjects:

Topics cited previously

- Dynamic optimization of a continuous non-linear process, by K.V. Mathew.
- Computer Control using a generalized model with self-checking, by J.W. Bernard.
- The dynamic behaviour of a gas absorption system, by G.A. Goulman.
- Dynamic response and control of a fluidized-bed chemical reactor, by A. Ichikawa.

Topics added

- Implementation of dynamic optimization of continuous non-linear process, by G. Basile and G. Marro(+).
- Computer control using a generalized model with adaptation, by O.P. Gerster.
- Dynamic optimization of continuous multi-stage process, by J.Z. Loeb.
- Transient behaviour of fluidized-bed chemical reactors, by J.A. Williams.

Group J. Artificial intelligence systems
Group Director: Dr. R.B. Banerji

This new group, directed by Dr. R.B. Banerji, is presently working on the following two research topics:
- Properties, concepts and recognition, by J.C. Pennypacker.
- Machine translation, by D.G. Gordon.

Group L. Life science systems
Group Director: Dr.D.G. Fleming

Two new topics are considered in this research group:
- regulation of respiration, by H.A. Fertik and R.H. Dutton.
- Analysis of electrophysiological correlates of learning, by J.R. Huntley.

Group M. Medical systems
Group Director: Dr. R. Plonsey (replacing the late professor D.P. Eckman, Director of the Systems Research Center who had previously also acted as this Group Director).

New research topics:
- Hospital systems research, by B.V. Dean.
- The need for patient classification, by J.T.R. Jackson.
- Effect of patient load on hospital costs, by K.P. Mohan-Ram.

Mr. J. Trevino is concerned with the topic:
- Therapy treatment scheduling in rehabilitation center.

On the other hand, the disappearance of some topics is compensated by the addition of the following new ones:

Topics cited previously

- Determination of optimal rehabilitation for chronically ill, by W. R. King.
- Effective utilization of nursing resources, by W. R. King.
- Systems research in electro-cardiology, by A. T. Bublitz.

Topics added

- Analysis of health, disability and care statistics on chronic illness, by B. C. Das.
- Effective utilization of nursing resources, by A.G. Beged-Dov.
- A multipole representation of the heart, by J. M. Hlavin.

Outside of the activity of the above 5 research groups A, C, J, L and M, the Systems Research Center visualizes the following additional research topic:
- The Great Lakes - St. Lawrence Water System, by R. C. Hain.

The next "Research Abstracts" shall be issued shortly, in June 1962.

THE 1962 AFIPS SPRING JOINT COMPUTER CONFERENCE

The AFIPS (American Federation of Information Processing Societies) held its Spring Joint Computer Conference in San-Francisco on May 1-3, 1962.

Various sessions were held at which the following papers - short abstracts of which are given here - were presented:

Session A. Study of business information systems

Toward a General Simulation Capability, by M. R. Lackner.

Simulation of a system by a digital computer requires:
- a model of the system which is intelligible to the student of the system while compatible with the limitations of the computer, translation of the model to computer code, moving the model through time and recording its performance,
- and an output presentation program.

SIMPAC, a "simulation package", incorporates coherent techniques and devices for the accomplishment of these objectives: modeling concepts for building a computer-compatible model, a vocabulary for encoding the model, a computer program for moving the model through time and recording its performance, and an output presentation program.

A model of an hypothetical business system has been implemented with the first version of SIMPAC for the purpose of studying management controls in a complex system.

This paper discusses digital simulation and SIMPAC, and introduces modeling concepts which may lead to a set of simulation systems which would assemble models of varying complexity from descriptive statements and analyse the models prior to simulation.

A NON-LINEAR DIGITAL OPTIMIZING PROGRAM
FOR PROCESS CONTROL, by R.A.
M u g e l e .

A new program has been developed for optimizing a computer-controlled process. This program applies probing and restraint-following algorithms which permit solving the optimization problem in difficult cases. These cases include non-linear or discontinuous restraint functions, and non-convex domains.

The program requires relatively little storage for program and data, and no special modifications of objective or restraint functions. It is primarily applicable to some medium-sized digital computers now used in process control.

Various control strategies are compatible with this program. It can be used to generate an operator guide for a process operating in the steady state. It can also be used for optimizing the control of a process with perturbed inputs, i.e. in the transient state. It can also be interrupted, before completion, in order to determine the degree of improvement available, or to impose new restraints.

A SIMULATION OF A BUSINESS FIRM,
by Ch. P. B o n i n i

This paper describes a simulation model of a hypothetical business firm. The model was constructed to include not only the accounting and economic factors of costs, profits, sales, units produced etc., but also psychological and behavioral concepts. Individuals in the firm have aspiration levels, feel pressure, and react in accordance with behavioral theory.

The purpose of the model is to study the effects of informational and organizational factors upon the decisions of a business firm. The authors have had limited knowledge of such variables as: the effects of tardy information, the effects of different distributions of information within the firm, the effects of differing degrees of centralization or decentralization, etc. A comprehensive model, such as the one proposed, is necessary to answer such questions.

Eight specific hypotheses involving changes in the organization and information system of the firm were formulated and tested using a factorial experimental design. The results of this experiment demonstrate the usefulness of this model as a research tool.

Session B. Theoretical problems in artificial intelligence

MH-1, A COMPUTER-OPERATED MECHANICAL HAND, by H. A. E r n s t .

MH-1 is a motorized and sensitized servo-manipulator operated by the TX-O computer at the Massachusetts Institute of Technology. Unlike in a conventional digital control system, the computer in the MH-1 system is not used to process quantitative information. Its function is rather to perceive and appreciate the environment of the hand qualitatively. On this basis, the computer determines a reasonable course of action after a goal has been specified for the hand.

Because of the automatic execution of these higher control functions the system, by itself, in its attempt to reach that goal, behaves sensibly even in unexpected situations for which no explicit instructions have been given. For example, it makes reasonably successful attempts to resolve inconsistencies between the plan of action and the situation in the environment, it finds a way around obstacles hindering the hand, or it accepts help from a human assistant without fighting back but it still resists unwanted interference. A film of MH-1 in action, demonstrating these properties, was shown.

AN ABSTRACT MACHINE BASED ON CLASSICAL ASSOCIATION PSYCHOLOGY, by R.F. R e i s s .

Classical association psychology (circa 1750-1900) described, and proposed to explain, human thought processes in terms of a few kinds of forces operating on discrete entities called "sensations", "images", "ideas" etc. The classical theory was not given a precise, quantitative formulation and has been generally abandoned for a variety of reasons. However, the problem of developing artificial intelligence in digital machines provides new grounds for evaluating and perhaps extending association theory.

One method of evaluation is the synthesis by postulation of abstract "machines" which reflect the fundamental insights of association theory, and analyses of their behavior. In this paper a minimal machine is defined and certain aspects of its behavior are examined. It is restricted to a finite system of discrete objects coupled by two types of associative bonds, some of which are modified by passage of the objects through an "attention" register. The system grows in size by the addition of new objects via a "sensory" register. Although this mission of new objects constitutes an over-simplified interpretation of association theory, it does display some of the diverse behavioral potentialities of such systems.

THE GODEL INCOMPLETENESS THEOREM AND INTELLIGENT MACHINES, by F. B. Cannonito.

This paper considers whether or not Godel's Incompleteness Theorem implies that machines are incapable of operating as intelligent robots. The paper's view is that the theorem does not limit machines in this sense. To support this belief, the concept of a recursively enumerable set of integers is developed via the intuitively appealing properties of programs made up from basic instructions similar to the wellknown initial functions of primitive recursion. Productive sets of integers are then introduced and after some remarks relating formal languages to sets of integers via the Godel numbering technique, a formal axiomatic arithmetic language L is defined and the recursive enumerability of L's set of theorems is asserted. The notions of w-consistency and interpretation of L are then given and Godel's Incompleteness Theorem is stated and interpreted vis-a-vis digital computers.

The paper then attempts to modify the concept of a program so that the theorem of De Leeuw, Moore, Shan-non and Shapiro can be introduced to argue that nonrecursively enumerable sets of integers can be generated by the modified programs under suitable restrictions. This is regarded as removing the restrictions on the use of machines as creative robots, implied by the Godel Incompleteness Theorem.

Session C. Digital Storage and Circuits

A SUPERCONDUCTIVE ASSOCIATIVE MEMORY, by P.M. Davies.

The general properties of an associative memory are explained, and their advantages relative to a random access memory discussed. Then a superconductive mechanization of such a memory is described which is based upon the cross film cryotron. The memory requires 5 cryotrons per bit and 9 cryotrons for a control module associated with each word. Any combination of bits of the word can be used as the key, and any number of records in the memory can be identified and read out as the result of a single association. The speed of various circuitry in the memory is approximated and some applications are suggested.

A CRYOGENIC DATA ADDRESSED MEMORY, by V.L. Newhouse, R. E. Fruin.

A Computer storage system which is addressed by content rather than location is described. The design has been verified by constructing and successfully operating a three-word module consisting of 81 crossed-film-cryotrons on a six-inch-by-three-inch substrate.

CIRCUITS FOR THE FX-1 COMPUTER, by K.H. Konkle.

A set of circuits capable of 50 megapulse operation is described. Included are gated and mixing pulse amplifiers, a static flip-flop, a diode logic unit with current-steering amplifier; a passive delay line, and an active variable delay circuit; all of which are designed to operate with terminated 75 ohm transmission lines. Ten nsec. pulses and 20 nsec. flip-flop transition times are provided through use of very-high-speed MADT transistors. The circuits have been successfully employed in the FX-1, a small general purpose computer with high-speed magnetic film memory.

Session D. Man-Machine Co-operation

ON-LINE COMMUNICATION BETWEEN MEN AND COMPUTERS, by J. C. R. Licklider and W. Clark.

The paper first reviews briefly the main problems and existing techniques of on-line communication between men and computers, and then describes three current developments:

1. A time-sharing system that permits several operators with independent problems to use one computer simultaneously, each operator having sensibly continuous access to its facilities.
2. A set of programs and techniques to facilitate planning and design of buildings.
3. Techniques that provide pictorial displays of what is going on inside the computer and reveal basic character-istics of traced-operating programs.

The paper concludes with a brief discussion of man-computer communication problems that call for basic advances in concept and hardware.

SOLUTION OF NON-LINEAR INTEGRAL EQUATIONS USING ON-LINE COMPUTER CONTROL, by G. J. Culler and R.W. Huff.

This paper contains results from some computer experiments performed as part of a study concerning more effective utilization of computers as research tools for scientific problems. A display and analysis console permitting direct control of the computer was used to solve a non-linear integral equation occuring in the Bardeen-Cooper-Schrieffer theory of superconductivity. This equation gives the energy gap in a superconductor as a function of energy after three physical parameters have been specified. In each case, the method of solution was constructed by the problem solver through direct interaction with the computer, the strategy of solution of each stage being based on information obtained from the computer in the course of the solution process. Thus, characteristic features of the problem and the pitfalls involved were discovered and controlled during the process of solution.

According to the parameter values specified, the problems ranged from very easy to quite difficult, and thus provided a basis for testing the authors approach. Extension of this technique to other digital equations, to more general one-dimensional problems, and to a wide class of physical and mathematical problems appears entirely feasible.

ARE THE MAN AND THE MACHINE RELATIONS ? by B.R. W o l i n .

As environments requiring control have become more complex, and the speeds of events in those environments have increased, there has been a trend to use computers to supplement or replace men or the functions they have traditionally performed. The decision as to how to use computers in systems has been influenced by beliefs about what men can and cannot do or should and should not do.

Additionally, attempts to employ computers have frequently failed because not enough has been known, either about the function, or how to program the computer to perform the function.

A research program is described which has two objectives: First, to study the behavior of men in complex environments to find out what they can and cannot do well, and what factors limit or extend their effectiveness. Second, to study the behavior of men to determine how they perform complex functions, using the men as analogues of general-purpose computers, so that computers can be better programmed to perform such functions when it is necessary to do so.

A brief description of the computerized laboratory in which the research is being done, and how the laboratory is being used, is included.

Session E. Data Analysis and Model Construction
in the Study of the Nervous System

PROBLEMS IN THE STUDY OF THE NERVOUS SYSTEM, by G. F a r l e y .

A survey is given of the main experimental and theoretical difficulties encountered in the study of the nervous system. These difficulties are illustrated by specific examples of the uncertainties still existing in knowledge of the behavior of neurons, both individually and in groups, and in the interpretation of experimental observations. Concepts of the reduction of data from electrophysiological experiments are discussed and compared with those in physical experiments. Some theoretical problems are similarly treated. Examples of analog and digital computers having both special and general-purpose features which have been used to attach these problems are given, with a brief discussion of some of the results.

NEURAL ANALOGS, by L.D. H a r m o n .

Information processing in the nervous system is receiving increasing attention by researchers in the communications sciences. One of the most prolific areas of activity has been neural modeling. Simple electrical and mathematical models were described over half a century ago; in recent years there has been a growing array of chemical, electronic, mathematical and computer-simulated analogs.

Two quite different kinds of neural modeling have resulted. In one category the intent is to simulate closely the complex parameters of the biological original in order to consider functions of the nervous system to supplement neuro-physiological research. In the second kind of neural modeling the idea is to explore the single-element logical behavior or the self-organizing properties of ensembles of relatively simple quasi-neural elements.

It is the purpose of this paper to emphasize the differences between these two approaches, to review briefly some of the main streams of activity in neural modeling, and to show, by way of example, the results of one particular line of investigation - the work dealing with real-time electronic neural analogs.

THE CAUDAL PHOTORECEPTOR OF THE CRAYFISH: A QUANTITATIVE STUDY OF RESPONSES TO INTENSITY, TEMPORAL AND WAVELENGTH VARIABLES, by W.R. U t t a l .

This paper describes the results of a study which has been made of the caudal photoreceptor of the crayfish. Pooled pulse potentials evoked by photic stimuli were recorded from the ventral nerve cord and these data digitized and recorded on magnetic tape. A digital computer was then used to analyze the data and recognise certain specific features. The coding of the nerve action potentials as a function of the stimulus dimensions was investigated and it was determined that the stimulus amplitude-response magnitude relation was a power function, with the same exponent as that found in human perception. Furthermore, the spectral luminosity curve was determined to coincide with that of the human eye.

The similarities of these two functions suggest a common photochemical medium which thus allows a detailed study to be made of these human perceptual processes in a highly reduced model preparation.

A THEORY AND SIMULATION OF RHYTHMIC BEHAVIOR DUE TO RECIPROCAL INHIBITION IN SMALL NERVE NETS, by R.F. R e i s s .

An elementary theory predicts that neurons which inhibit each other, and which suffer "fatigue" with repeated firing can produce alternate bursts of pulses, a "multivibrator" effect,

under certain conditions. Fragmentary physiological evidence suggests that reciprocal inhibition does occur in sensory and muscle control systems, and may in particular explain rhythmic behavior of the sort seen in alternating reflexes-responsible for animal locomotion.

On the basis of a specific conceptual model of signal processing in neurons, analog and digital simulation models have been constructed and used to explore the multivibrator effect. The effect is rather easily produced with model neurons operating in either "coincidence" or "relaxation" modes, and is facilitated within limits by asymmetric parameters.

The reported simulation experiments are restricted to reciprocal inhibition of just two neurons and indicate that a neuron couplet, with a few sensory inputs and proprioceptive feedbacks, could provide an economical control system for alternating reflexes or for synergetic muscle groups which time-share a common load. Such a system could rapidly adapt to varying loads and would require minimal control from higher nervous centers. The exploration of many other possible functions for two (and more) multivibrator effects in small nerve nets has only begun.

Session F. Computer Systems

THE MANIAC III ARITHMETIC SYSTEM, by R. L. A s h e n h u r s t.

Unlike most computers, for which there is a formal distinction between "fixed-point" and "floating-point" numbers, the University of Chicago Maniac III computer handles all numbers in a single format (exponent and coefficient, with the coefficient in general not normalized). This permits several types of arithmetic to be defined, which differ in that results are adjusted (coefficient scaled) according to different rules. For example, a "floating-point" operation adjusts the result according to a "significant digit" criterion, while a "specified point" operation adjusts the result to the exponent of first operand. Normalized arithmetic and a fourth type called "basic" are also available. Since the format for operands is the same for all these types, they can be processed by the various arithmetics without intermediate conversion, thus adding a dimension of flexibility to the computing process. This paper discusses the arithmetic rules in some detail, showing how consistent conventions for rounding, adjustment of zero and formation of low-order parts are established. The trapping system used for the detection of anomalous results is also described.

AN ORGANIZATION OF AN ASSOCIATE CRYOGENIC COMPUTER, by R.F. R o s i n.

This paper is concerned with the organization of a computer built entirely of cryotrons and operating with an associative (content addressed) memory in which the location of words stored or retrieved is determined by all or part of the contents of the words.

Since cryogenic circuitry is used throughout, the speed of the machine is relatively uniform in both memory and other functions. Thus, the traditional balance of operation time is changed from that existing in more contemporary devices. Moreover, the problem of hardware maintenance has changed due to the very cold environment which must exist for the machine to operate.

A design approach to these and other considerations is evolved which includes putting more logic than usual into the memory and eliminating the necessity for a distinct instruction location counter, address decoder, etc.... Problems considered include multi- and parallel processing, indexing and indirect addressing, input-output processing and self-monitoring functions.

INTEGRATION AND AUTOMATIC FAULT LOCATION TECHNIQUES IN LARGE DIGITAL DATA SYSTEMS, by D. W. L i d d e l l

A digital computer, if used with proper programming techniques, can be a powerful tool during the processes of physical integration of complex digital data processing systems. After system integration as such has been completed, the same technique may be used to provide performance monitoring and daily calibration status data for all or any part of a system.

Investigation of such programming techniques during system integration of the Developmental Navy Tactical Data System (NTDS) at USNEL produced results which indicated the possibility of using the computer for automatic fault location in the system. Some progress has been made in this area, and a program which allows the NTDS computer to identify a failing logic card associated with its own memory logic and switching circuitry has been successfully demonstrated. The final objectives of this approach are to provide facilities to perform on-line performance monitoring and automatic fault location, reduce to a minimum the external test equipment required for a system, and eliminate insofar as possible the high degree of training presently required in the system maintenance technician.

Session G. Analog Applications and Techniques

THE USE OF COMPUTERS IN ANALYSIS, by W. J. Karplus and L. D. Kovach.

The computer is recognized as an important engineering design tool permitting the student to test the efficacy of a large number of design hypotheses to determine an optimum design. The application of automatic computers to courses in methods of analysis, however, has not been clearly defined. This paper gives a number of specific examples of the utilization of computers in engineering analysis. Foremost among these examples are two categories of computer utilization:
1) The application of computers to aid the student in the visualization of dynamic or mathematical phenomena;
2) the opening up of new approaches to the explanation of system behavior - approaches which are out of reach of conventional analytical methods.

ANALOG SIMULATION OF PARTICLE TRAJECTORIES IN FLUID FLOW, by V. D. Norum, M. Adelberg and R. L. Farrenkopf.

This paper presents a detailed account of the analog simulation of particle trajectories in a two-dimensional fluid flow field governed by Laplace's equation. A conductive surface is used as a direct analog of the two-dimensional fluid flow field in conjunction with an electronic analog computer to determine the trajectories or particles in the presence or fluid flow. Emphasis is placed on the concept of accuracy of the particle trajectories as well as error criteria by which trajectory accuracy can be judged; and on the sources of error inherent in their determination.

A detailed error analysis is presented in which a suitable error model is derived and certain inaccuracies in the computing equipment are assumed in order to predict their effect on the particle trajectories. An example is presented to illustrate the types and magnitudes of errors that exist in a typical problem. The analog simulation is also used to obtain trajectories in a potential flow field distorted by the presence of a cylinder and the results are then compared to a similar case obtained by other authors using a different approach. These results were comparable, with suitable explanations for the difference.

THE APPLICATION OF FINITE FOURIER TRANSFORMS TO ANALOG COMPUTER SIMULATIONS, by E. Liban.

An analog computer technique for the solution of certain classes of boundary value problems of partial differential equation based on Finite Fourier Transforms is presented, which requires considerably less computer components than conventional finite

difference methods. The derivation of the Finite Fourier Transform method is briefly stated and then applied to analog computer simulation of heat transfer equations with linear and non-linear boundary conditions.

ANALOG SIMULATION OF THE RE-ENTRY OF A BALLISTIC MISSILE WARHEAD AND MULTIPLE DECOYS, by L.E. Fogarty and R. M. Howe.

The basic problem considered here is the computation of the re-entry trajectory of a single ballistic missile warhead as well as the trajectories of a number of decoys which originate from the warhead trajectory. Suitable three-dimensional equations of motion are presented for a re-entry vehicle with arbitrary drag coefficient, mass, and area, and the analog computer circuit for solving these equations in real time is given. Then a method of using several such circuits to compute simultaneously the trajectories of multiple targets with variations in all three initial velocity components as well as variations in ballistic coefficient is presented.

Session H. Information Retrieval

THE CONSTRUCTION OF AN EMPIRICALLY BASED MATHEMATICALLY DERIVED CLASSIFICATION SYSTEM, by H. Borko.

This study describes a method for developing an empirically based, computer derived classification system. Six hundred and eighteen psychological abstracts were coded in machine language for computer processing. The total text consisted of approximately 50.000 words of which nearly 6.800 were unique words. The computer program arranged these words in order of frequency of occurrence. From the list of words which occurred 20 or more times, excluding syntactical terms such as and, but, of, etc. ..., the investigator selected 90 words for use as index terms. These were arranged in a data matrix with the terms on the horizontal and the document number on the vertical axis. The cells contained the number of times the term was used in the document. Based on these data, a correlation matrix, 90 x 90 in size, was computed which showed the relationship of each term to every other term. The matrix was factor analyzed and the first 10 eigenvectors were selected as factors. These were rotated for meaning and interpreted as major categories in a classification system. These factors were compared with, and shown to be compatible but not identical to, the classification system used by the American Psychological Association. The results demonstrate the feasibility of an empirically derived classification system and establish the value of factor analysis as a technique in language data processing.

THE STORAGE AND RETRIEVAL OF PHYSIOLOGICAL AND MEDICAL DATA IN A MODERN HOSPITAL, by P. C. T i f f a n y .

As an introduction, this paper considers some of the problems of data handling in a modern hospital. Next the needs of the users of the data are considered. The principal area of interest is directed toward the hospital function which deals with the storage and retrieval of the clinical record after the patient's hospitalization. An estimation is made of the large amounts of terms used in medicine, and of two currently employed schemes for the indexing of diseases and operations. A description is made of a storage and retrieval system which allows the medical researcher to examine and browse through clinical records or abstracts of the records. The paper concludes with observations on the need for applied research and system development to acquire pilot systems for the storage and retrieval of physiological and medical data.

Session I. Programming and Coding

FACT COMPILER SEGMENTATION, by M. N. G r e e n f i e l d .

The manner in which the fact Compiler handles segmentation of programs is described. Programs are divided into many interdependent segments in order to optimize the use of core storage. For instance, the internal storage required to handle a tape file (buffers, labels, controls) would be one segment. This segment would be operated upon by other processing segments. Each of the segments may be activated or released independently as required. Each of the segments is relocated at execution time. Segments in memory may be subsequently moved by the monitor in order to fit additional segments in core. The monitor has the ability to organize the required rearrangements. A hardware error detection feature is used to make the currently operating segments sensitive to the absence of a segment about to be addressed. This provides an efficient linkage to the monitor enabling it to activate the segment.

A GENERAL TEST DATA GENERATOR FOR COBOL, by R. L. S a u d e r .

Program checkout procedures are often hampered by the non-availability of adequate test data. To reduce this problem, a Test Data Generator is currently being developed to operate in conjunction with the Cobol Compiler implemented by the Air Force Logistic Command. The system not only builds data items conforming to descriptions given in the Data Division of the associated Cobol Source Program but also inserts in these items necessary data relationships and requirements to test various branches of the Cobol object program. The generator is label-requirements is designed to be as hardware independent as the Cobol compiler employed to build the program being tested. This paper discusses both the utilization and the method of operation of the Data Generator.

DATA STRUCTURES THAT GENERALIZE RECTANGULAR ARRAYS, by S. A. H o f f m a n .

A class of data structures, useful in data processing, is defined. These are called generalized structures. A formal method of describing a generalized structure is given. It is shown how a compiler program, once given such a description or descriptor, can allocate contiguous storage and determine the appropriate form of the storage mapping function which will relate suitably referenced positions in the structure with positions in the linear storage. The suitable referencing of data in the structure is accomplished by reference expressions, these are defined and it is shown how, at run time, they are operated upon by the storage mapping function.

The class of structures, the descriptors, the form of the storage mapping function and the reference expressions are all shown to be direct generalizations of the corresponding considerations for n-dimensional rectangular arrays.

Finally, an Algol program for the Burroughs 220 computer is briefly described. The program simulates the functions that a compiler, upon receiving a descriptor, would perform in forming the storage mapping function, and the processing that would be carried out at run time when a reference expression is presented.

AN EXPERIMENTAL TIME-SHARING SYSTEM, by F. J. C o r b a t o .

Time-sharing a digital computer is subject to two common interpretations. One can mean using different parts of the hardware at the same time for different tasks, or one can mean several persons making use of the computer at the same time. The first meaning, often called multiprogramming, is oriented towards hardware efficiency in the sense of attempting to attain complete utilization of all components. The second meaning of time-sharing, which is meant here, is primarily concerned with the efficiency of persons trying to use a computer. Computer efficiency must still be considered but only in the perspective of the total system utility.

The motivation for time_shared computer usage arises out of the slow man-computer interaction rate possible with the bigger, more-advanced computer. This rate has changed little (and become worse in some cases) in the last decade of wide-spread computer use. The desired performance of a time-shared computer is discussed as well as specific hardware, programming and usage problems. The operational characteristics of an experimental time-sharing programming system prepared for an IBM 7090 is described. Consideration is given to the design compromises and to the future avenues of improvement.

A PROGRAMMING LANGUAGE, by K. E. I v e r s o n .

The paper describes a succinct problem-oriented programming language. The language is broad in scope, having been developed for, and applied effectively in, such diverse areas as microprogramming, switching theory, operations research, information retrieval, sorting theory, structure of compilers, search procedures, and language translation. The language permits a high degree of useful formalism. It relies heavily on a systematic extension of a small set of basic operations to vectors, matrices, and trees, and on a family of flexible selection operations controlled by logical vectors. Illustrations are drawn from a variety of applications.

Session J. World Peace and Role of Computers

A panel discussion took place on this topic.

Session K. Digital Differential Analyzers
and Hybrid Computation

DESIGN OF A ONE-MEGACYCLE ITERATION RATE DDA, by R. E. B r a d l e y and J. F. G e n n a .

This paper discusses the special design features of a digital differential analyzer (DDA) which operates at a rate of one million iterations per second. SPEDAC (Solid-state Parallel Expandable Differential Analyzer Computer) features parallel organization of the integrators, serial-parallel arithmetic within the iteration cycle, 26-bit word length, and the integral inclusion of a multi-function digital function generator. The computer is programmed in analog computer fashion by means of plug board interconnection of the integrators.

To achieve a one-megacycle iteration rate, the arithmetic circuits operate at a six-megacycle clock rate. Trapezoidal integration is performed. Initial conditions and function generator breakpoints and slopes are stored as parallel words in a multi-plane magnetic core memory. The use of a parallel memory is exploited to permit direct parallel communication and hybrid operation with external large-scale general-purpose digital computers.

DDA ERROR ANALYSIS USING SAMPLED DATA TECHNIQUES, by D. J. N e l s o n .

The Z or W-Transforms may be combined with matrix techniques to analyze errors in digital differential analyzers. This analysis demonstrates how errors in the solution of linear differential equations with constant coefficients can be simply determined and how solutions to these equations can be determined, the accuracy of which is limited only by round-off.

HYBRID TECHNIQUES APPLIED TO OPTIMIZATION PROBLEMS, by H.S. W i t s e n h a u s e n .

A hybrid system is described consisting of a general-purpose analog computer and a specially designed digital expansion system (DES). One of the functions of this expansion is to act as an intelligent operator of the analog high-speed computing capability. To this end, the expansion contains logic build-ing blocks (essentially flip-flops and gates) interconnected on a patch-panel. Switching commands are transmitted from the DES to analog gates, memory units and mode control. Compara-tors transmit quantized information from the analog to the DES.

Application of this simplest capability of the hybrid approach is illustrated for the optimization problem, stated as follows:

A function dependent on the solution of a set of differential and/or algebraic equations containing adjustable parameters is to be minimized by systematic search procedures in parameter space. Among the applications are model building, process op-timization and matching of boundary conditions. One possible procedure has been selected for illustration and its hybrid implementation is carried out for the general n-parameter case. Exploratory runs determine approximate partial derivatives from which a quantized direction is determined. Steps are taken in this direction until lack of improvement forces a redetermination of partials. The techniques of programming the DES and the hybrid interconnections are emphasized.

PUBLICATIONS

International

(Remark: The numbers before the titles refer to the tentative Classification as published in Bulletin No.11, pp. 37 - 52)

ACTA IMEKO 1961
6.9.1

The Proceedings of the IMEKO Congress held in Budapest in 1961 are scheduled for publication in the immediate future. They will contain the 133 papers read at this Congress by experts from 22 countries; each paper will be published in one of the following 4 languages: English, French, German or Russian with summaries in the 3 other languages.

The Proceedings will contain approximately 2.500 pages of text, 800 illustrations and be divided into 5 volumes. The price will be $ 18.

5.6.30 PROCEEDINGS OF THE INTERNATIONAL SEMINAR ON ANALOGUE COMPUTATION APPLIED TO THE STUDY OF CHEMICAL PROCESSES.

We have already reported in our Bulletin No. 9 (pages 11 to 18) on this Seminar held in Brussels on November 21-23, 1960, and have given short abstracts of the 21 papers read.

The Proceedings of this Seminar, including the discussions plus an additional 22nd paper, have been published by Presses Académiques Européennes, Brussels. They comprise 170 pages of text and numerous figures; the papers and discussions are published in English, French or German.

Czechoslovakia

5.5.0 SYMPOSIUM ON AUTOMATIC CONTROL OF POWER BLOCKS, Prague 1961. Published by Československa Vědecko-Technická Společnost, Prague 1, Siroká 5.

This volume contains the papers read at the Symposium in the original languages (English and German). A survey report on this Symposium has been published by R. Q u a c k in German language in the magazine Brennstoff-Wärme-Kraft (BWK) 1961, No. 12, pp. 552 - 556.

France

4.0.2.1 INVESTIGATION AND DESIGN OF HYDRAULIC SYSTEMS (Etude et Détermination des systèmes hydrauliques). In French by M. Guillon. Paris, Dunod, 1961, 444 p., 248 illus.

Germany

1.1.2.1 GUIDE TO PRACTICAL USE OF THE LAPLACE TRANSFORM (Anleitung zum praktischen Gebrauch der Laplace Transformation) by G. Doetsch, in German. München, R. Oldenbourg Verlag, 1961 (2nd edition), 256 p., 45 illus., DM 38.--.

1.1.6.0 APPLICATION OF STATISTICAL METHODS IN AUTOMATIC CONTROL (Anwendung statistischer Verfahren in der Regelungstechnik) by H. Schlitt, Editor. In German. München, R. Oldenbourg Verlag, 1962, 90 p., 41 illus., DM 16.80.

4.4.1.1. LINEAR IMPULSE AMPLIFICATION (Lineare Impulsverstärkung) by W. Rupprecht. In German. Hamburg, R. von Decker's Verlag, 1962, 45 p., 31 illus., DM 5.80.

Switzerland

INTRODUCTORY AUTOMATIC CONTROL LECTURES

We have already published in our Bulletin No. 7 (pages 14 to 15) the programme of lectures on Automatic Control organized, during the winter 1959 - 1960, by the Geneva Section of ASSPA. These lectures have now been published in French and are available, at a price of 15 Swiss francs, from the Geneva Section of ASSPA (postal account I 15387, Geneva).

United Kingdom

4.0.1.0. LINEAR ELECTRIC CIRCUITS (translated from Hungarian into English) By Z. Hennyey. Oxford, Pergamon Press, 1962, 335 p., £ 5/-/-.

4.1.2 MICROMINIATURIZATION (Proceedings of the NATO Conference, Oslo, July 24-26, 1961). By G. W. A. Dummer, Editor. In English and French. Oxford, Pergamon Press, 1962, 450 p., £ 5/5/-.

4.0.1.2. PRINCIPLES OF ELECTRONIC INSTRUMENTATION. by W.A. Lynch and J.G. Truxal. New York, McGraw-Hill, 1962, $7.50.

This book is designed to follow the author's first volume, Introductory System Analysis, to provide a modern and comprehensive one-year course for science and engineering curricula other than electrical engineering. It may also be used as a second-semester course in the field of instrumentation for students working toward a bachelor's degree in non-electrical engineering areas who have had a more conventional first semester introductory electrical engineering course.

The introductory chapter summarizes the highlights of linear system theory covered in the first volume. The inclusion of this introductory chapter makes the text independent of Volume I.

The term instrumentation is interpreted in the modern sense as encompassing not only the measurement of electrical quantities, but of physical variables in all fields of engineering, the conversion of signals from one form to another, and the utilization of feedback-control principles in the design and implementation of basic instrumentation functions.

The approach is in terms of a unified system point of view, utilizing a wide variety of the modern electrical engineers' approaches and techniques. The model concept and the transfer-function concept are continually emphasized and applied, making use of such powerful tools as the complex frequency and transform methods.

Volume I in the series is entitled:

4.0.1.2 INTRODUCTORY SYSTEM ANALYSIS: SIGNALS AND SYSTEMS IN ELECTRICAL ENGINEERING. By W.A. Lynch and J.G. Truxal. In English. New York, McGraw-Hill, 480 p., $7.50.

This text focuses on the presentation of linear system analysis, one of the fundamental concepts underlying the subjects of instrumentation and control engineering, electronic circuits, and analog simulation and computation.

The primary objective is to present the fundamental concepts and techniques of modern electrical engineering by introducing the viewpoints, approaches, and methods of the electrical engineer; familiarizing the reader with electrical devices and equipment; providing the requisite foundation for future study; and presenting a definitive picture of the role of the electrical engineer in the modern interdisciplinary systems engineering efforts, both military and industrial.

The basic techniques of system analysis are presented simply, yet completely, omitting many widely-taught techniques in order to focus attention on basically important areas. Unusual topics are treated, including analog computers, complex-frequency techniques and the essential results of the Laplace transform, signal analysis, mechanical and other networks, and signal-flow graphs.

A combined volume, including the same material that is found in volumes 1 and 2 (except that the unifying chapter at the beginning of volume 2 will be omitted) will also be published under the title of "Signals and Systems in electrical Engineering."

NOTE ON INFORMATION BULLETIN NO. 14

Information to appear in the Information Bulletin No. 14
should reach the Editor:

Professor Ing. Dr. V. Broida
Honorary Editor of I.F.A.C.

13, rue de la France-Mutualiste

Boulogne-sur-Seine (Seine), France

not later than October 15th, 1962.