# Organization of Simulation Councils, Inc.

THIS YEAR Simulation Councils, Inc., accepted with great pleasure S. N. Alexander's (1957 EJCC Chairman) invitation to hold its annual meeting in conjunction with the Eastern Joint Computer Conference. This allowed members of the regional groups to meet at a national conference where all members had a definite interest. The Simulation Councils participated in two of the formally scheduled sessions, and in addition, four informal sessions were held at which papers were presented by its members.

The following background information is provided to familiarize members of the AIEE, ACM, and IRE with the objective of the Simulation Councils.

Simulation Councils, Inc., is an organization formed to improve communications at the working level concerning methods of using simulation techniques and equipment to facilitate the study, design, test, and analysis of physical systems. These objectives are quite broad and naturally are very much related to the use and application of electronic computation.

The beginning of this organization occurred in November, 1952, when a group of persons associated with the operation of general purpose analog computers decided to hold informal meetings for discussing the details of problems and methods for their solution, equipment, and new ideas. It was decided that the minutes of such meetings would be published in an informal newsletter which would be made available to all those interested, including those who were unable to attend.

The group holding this first meeting evolved into the Western Simulation Council. Following the same concept and procedures, five other Councils were organized: the Midwestern Simulation Council, Eastern Simulation Council, Central Simulation Council, Southeastern Simulation Council, and the Canadian Simulation Council. All these Councils have joined into an international group which is called Simulation Councils, Inc. The purpose of this group is to provide a medium for publishing the minutes of the meetings of all regional groups, and to arrange annual meetings to which all the regional groups are invited.

The entire concept of the Simulation Councils is based on informality. Membership in any one of the regional groups may be obtained by attending a meeting and signing the attendance register, or by requesting the Chairman of that Council to place your name on the mailing list.

Meetings are held approximately every second month with from 20 to 100 members in attendance. The meetings usually are held at the computing facilities of organizations interested in simulation. An attempt is made to choose different hosts for each meeting so members may visit a wide variety of simulation and computational facilities. Meetings usually begin with brief talks on a subject selected to promote discussion, and an attempt is made to encourage all present to join in the discussions. This informal discussion is the essence of the Simulation Councils effectiveness; everyone gets a chance to compare his technique and equipment with others having similar interests and problems.

The *Simulation Council Newsletter,* as informal as the Council discussions, has appeared every month since November, 1952. At first it was privately published by mimeograph, but increased demand made this impractical and since April, 1955, it has appeared as a separate and editorially autonomous section of *Instruments and Automation.* Individual issues of the *Newsletter* are as different as the wide variety of subjects and the personalities of people discussing them. The result is that while reporting month after month the offhand remarks as well as the serious thoughts of those developing the techniques and designing the equipment for simulation, the *Newsletter* reflects progress in the allied fields of analog and digital computation and data processing as well.

Anyone interested in the Simulation Councils is invited to contact the Steering Committee Chairmen of the various regional groups listed below.

*Western Simulation Council*
Dov Abramis, Convair, Pomona, Calif.

*Midwestern Simulation Council*
Warren Jackson, Standard Oil Co., Midland Building, Cleveland, Ohio

*Eastern Simulation Council*
Hideo Mori, Hydel, Cambridge, Mass.

*Southeastern Simulation Council*
Robert Johnson, Georgia Institute of Technology, Research Area 4, Atlanta, Ga.

*Central Simulation Council*
James Pierce, Beech Aircraft, Wichita, Kan.

*Canadian Simulation Council*
F. W. Pruden, Analog Computation and Simulation Group, Mechanical Engineering Division, National Research Council, Ottawa, Ont., Canada

## Abstracts of Papers

Papers presented by members of the Simulation Councils, Inc., at the four informal sessions during EJCC are abstracted on the following page.

1) *Physical Simulation in Airplane Control System Problems,* P. G. Hurford, McDonnell Aircraft Corp. This paper describes the use of physical simulation including the pilot as an aid in the solution of lateral control problems of modern jet fighters. To accomplish this, an analog computer and control system are combined with a movable chair which imparts to the pilot the "feel" of rolling motions. The effects of various chair, control systems, and airframe parameters are determined with this system.

2) *Design and Utilization of a Three-Axis Simulator,* M. Paskman and R. Edwards, Aircraft Armaments, Inc. The time and cost savings resulting from utilization of a three-axis simulator are discussed. The design evolution of a three-axis, gimballed system is described, including specifications, mechanization, and analysis of the system. Test procedures are outlined, after which the use of a general purpose analog computer to solve typical control system problems is described.

3) *Synthesis of Closed-Loop System by Means of Analog Computers with Real Gyros or Accelerometers in the Loop,* B. W. McFadden, Micro Gee Products, Inc. Presented are the advantages and techniques in the synthesis of a closed-loop system (such as an autopilot or autonavigational system) by including the real gyro or accelerometer in the loop with an analog computer. Also given are the characteristics of a simulation table with a threshold of less than one second of arc which makes it possible to determine closed-loop performance about null under the influence of real, small discontinuous nonlinearities such as friction, noise, and deadband.

4) *A Discussion of the Procedures and Practical Problems Relating to Real-Time Simulation Using Control System Hardware,* Eaton Adams, Jr., Convair, Fort Worth, Texas. The techniques and problems involved in real-time flight simulation using hardware are described. A three-degree-of-freedom missile trajectory problem, including nonlinear aerodynamics, is used as an example. Problems of analysis and correlation with analytic results when nonlinear hardware is included in the simulation are discussed, along with other difficulties arising in such a simulation.

5) *A New Dead Time Simulator for Electronic Analog Computers,* Millard Brenner and Jerome D. Kennedy, Electronic Associates, Inc. Up to now, the accurate simulation of dead time, performance of auto and cross correlations, and long-term arbitrary function storage have been difficult to achieve on an electronic analog computer. This paper deals with the applications and operational principles of the SIMULAG, a variable delay, multichannel magnetic tape unit developed by Electronic Associates, Incorporated.

6) *A. C. Diode Function Generators,* C. L. Cohen and D. S. Peck, Nuclear Products—Erco Division of ACF Industries, Inc. Circuits employing silicon diodes as used in aircraft flight simulators are described. The circuits involved perform function generation such as slope changing, limiting, jump functions, absolute value generation, and magnitude selection.

7) *Future of the Transistor Analog Computer,* Robert Bruns and George Milligan, Jet Propulsion Laboratory, California Institute of Technology. A portable analog computer employing transistors has been developed to study the possibility of analog computers employing semiconductor devices only. The transistor operational amplifier and servomultiplier circuits for this computer are described, along with the performance capabilities of these components. The direction of future analog computer design is discussed.

8) *Open-Shop Operation of a Large Real-Time Simulator,* Stanley Rogers, Convair, San Diego, Calif. The problem of maximizing the use of simulators under open-shop conditions is reviewed. Topics include scheduling, operator training, equipment reliability and maintenance, problem-checking methods, and suggested future trends for large simulators.

9) *A Real-Time Simulation System for Use with an Analog Simulator,* Robert M. Beck and Max Palevsky, Packard-Bell Computer Corp. Reported are some newly developed digital devices which can be employed with analog computers. These devices include an extremely high speed incremental computer for computing nonlinear analytic functions, a function generator that employs photographic techniques for storage, and a 0.01 per cent analog-to-digital and digital-to-analog converter. The converter also performs multiplication and division within the conversion process.

10) *Simulation of Aircraft Landing Gear Dynamics on the Geda Analog Computer,* P. J. Hermann, Goodyear Aircraft Corp. A simulation of the vibration dynamics of a landing gear has been set up in order to study the effects of braking torques and other influences in exciting the landing gear into undesirable vibration amplitudes. Assumptions in formulating the physical model of the landing gear are discussed, as well as the development of the equations of motion. The difficulties in determining numerical values for the various constants are related, and the results of the computer simulation are presented.

11) *Direct Simulation on Analog Computers through Signal Flow Graphs,* Louis P. A. Robichaud, Canadian Armament Research and Development Establishment. For physical systems which can be considered as made up of combinations of various elements, it is not necessary to write out the equations before determining the analog computer circuit. A procedure is presented for going directly from a physical system to an analog computer representation of that system. Each physical unit is represented by a computer unit such that all terminal variables are in evidence in that unit as they are in a matrix or flow graph representation of the physical unit. The computer units then are interconnected in a manner similar to the physical units.

12) *The Use of Quaternions in Simulation of the Motion of Rigid Bodies,* A. C. Robinson, Wright Air Development Center. In simulation involving real three-dimensional coordinate transformations, it is customary to represent orientation by Eular angles or direct cosines. The use of the four-parameter quaternion notation which avoids both "gimbal lock" and redundancies is outlined. It is shown that from the standpoint of accuracy and amount of equipment required, the quaternion method is superior to either of the two usual techniques. Other advantages and limitations are set forth.

13) *On the Loop and Node-Analysis Approach to the Simulation of Electrical Networks,* Joseph Otterman, University of Michigan. Simulation of an electrical network on an analog computer by the loop or node-analysis approach is quite often unsatisfactory because of hidden regenerative loops. Such regenerative loops arise when the computer setup contains more integrators than the order of the differential equation describing the network. Instability may result because the actual computer components in the loop containing an excess integrator depart from ideally exact, prescribed values. Presented is a procedure for tracing the loop currents in such a way that there is one-to-one correspondence between the number of integrators in the simulation setup and the count of independent energy-storing elements in the network, *i.e.,* the order of the differential equation describing the network. The generality of the procedure proves that it is always possible to trace the loop currents in such a way that excess integrators are avoided. A parallel procedure for node analysis is discussed briefly.

14) *Application of High Speed Compressed Time Scale Computer to Engineering Problems,* Joseph Miasnick, General Electric Co. Application is made of a high-speed compressed time scale computer to certain engineering problems. The place of this type of computer in the over-all problem-solving picture is described. Specific application is made to the simulation of the performance of a starter-engine combination. The simulation is used to determine the effect in performance of varying cutout speed, torque-speed characteristics, and engine application. The computer also is used to determine the inertia of the test stand.

15) *Simulator for Use in Development of Jet Engine Controls,* Emile S. Sherrard, National Bureau of Standards. Recommendations and cost estimates for a simulator capable of representing a twin-spool, after burning, turbojet engine and its controller are given. The simulator is intended as a tool to be used by a group of engineers engaged in developing engine control systems. The simulator is designed to determine stability and performance of the engine control system, to be useful in both early and late stages of the development, and to operate in real time so control hardware may be operated with a simulated engine.

16) *Ducting Air-Flow Characteristics By Electrical Circuit Measurements,* William H. Sellers, General Electric Co. The well-known dynamical analogies are developed and reviewed for electrical, mechanical, and acoustical systems. The analogous electrical circuit then is derived for a physical system consisting of a cylindrical tube, containing a butterfly valve arbitrarily located within the tube. An actual circuit consisting of inductances, capacitors, etc., is then constructed and the values of voltages and currents are recorded by a brush recorder. These recorded values are analogous to the pressure and flow of the fluid within the duct. Photographs are presented depicting the actual wiring and measurement arrangements. Also, a comparison solution, obtained by a standard analog computer, relates the relative error and reliability of the direct circuit measurement method.

17) *The Real Time Simulation of Turbo-Jet and Turbo-Prop Engines and Controls,* D. L. Dresser, Allison Division, General Motors Corp. Some problems faced by the designer of control systems for turbo-jet and turbo-prop engines are outlined. The use of the analog computer as a tool in designing controls for future engines and testing hardware is discussed. Two specific examples of full-scale simulation are presented. The first one is a turbo-jet simulation based upon component turbine and compressor date, and the second one is a turbo-prop simulation which uses test-stand dynamometer data. Also, two linearized procedures are given. Computer techniques for representing a variety of nonlinearities are described.

18) *Noise and Statistical Techniques in Analog Simulation,* Henry Low, The Ramo-Wooldridge Corp. The role of the analog computer in obtaining the impulse response of a linear system is discussed, including the adjoint method for obtaining the impulse response of time-varying linear systems. Techniques for treating nonlinear systems on an analog computer are discussed. The types of statistical quantities corresponding to random inputs to the analog computer are described, and an illustrative example is worked out. The theory of operation of various types of analog computer noise generators is explained. Techniques for measuring the statistical characteristics of low-frequency noise generators are presented.