DEFINITIONS OF TERMS USED TO SPECIFY GENERAL-PURPOSE ANALOG COMPUTERS

Jack E. Sherman

In recent years it has become increasingly obvious that there are considerable ambiguities in some of the terms commonly used in specifying components and performance criteria of analog computers. Examples of ambiguities are: “Accuracy” as applied to analog computers, the definition of an electronic multiplier, etc. In an effort to bring some uniformity to this area, Dr. Hans R. Meissingner, Chairman of the Western Simulation Council, appointed a committee in November 1960 to decide upon a set of standard definitions of terms used in specifying analog computers. The members of the committee are shown in the photograph.

The primary goal of the committee is to define terms commonly used in specifying analog computers. In order to define some of these terms, it is necessary to describe the methods by which certain measurements should be made. Therefore the definitions are divided into two parts: (1) Definitions of Terms Used to Specify Analog Computers, and (2) Measurement Procedures.

One often hears of an analog computer having an “accuracy of 0.01%”. This is obviously erroneous. The statement should read that the computer has “an error of less than 0.01%”, or that the computer has “an accuracy of 99.99%”. Then there are other kinds of ambiguities. For example, it has long been the practice of the industry to claim “an accuracy of 0.02%” for electronic multipliers. However, when it comes to measure the performance of the component in question, it develops that the interpretation put on this figure by the manufacturers is 0.02% of full scale (±100 volts), and is then interpreted by them as being ±40 millivolts. The reasoning they used in arriving at this conclusion is that it is possible for the peak-to-peak value of the signal to be 200 volts, and they say that 0.02% of 200 volts is 40 millivolts. However, the point that they choose to suppress is that the term ±40 millivolts is really 80 millivolts peak-to-peak, which is 0.04% of the peak-to-peak signal value. Further, these specifications apply to the multiplier only when the inputs are essentially stationary. There is no convenient or commonly accepted method of specifying the dynamic performance of the multiplier.

When the term “electronic multiplier” is used, it is at times not clear exactly what is meant. Does it merely require inputs of X and Y from any source? Or does it require inputs of both plus and minus X and plus and minus Y, all from low-impedance sources? Can the output be fed directly to a low-impedance termination, or must it be terminated in a high impedance? It is clear that there may be a difference of five amplifiers between the two cases.

The Western Simulation Council Committee on Uniform Specifications for Analog Computer Performance was formed to clarify these and like situations. The definitions proposed by the Committee have been discussed with technical representatives from several of the leading manufacturers of analog-computing equipment. The final report of the Committee will be submitted to the Board of Directors of Simulation Councils, Inc., for approval. After approval by the Board of Directors of Simulation Councils, Inc., the definitions will be submitted to the American Standards Association, the IRE, the AFIPS and the IFIPS.
The first full range, full power transistorized operational amplifier

A true technical breakthrough, the new Donner Model 3821 solid state dc operational amplifier* provides the powerful output and range needed to drive, without additional circuitry, galvanometers, process control elements, servo-control equipment, and electro-hydraulic systems.

Or you can convert and update your present analog computer with plug-in simplicity to obtain a 30-fold increase in reliability. The new amplifier is completely interchangeable. And to finish the job, Donner offers a full line of solid state multipliers, squaring networks, and other analog computer elements.

A look at the table shows you the power of the new Donner operational amplifier.

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>Current Output</th>
<th>Output Voltage</th>
<th>Current Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 v</td>
<td>20 ma</td>
<td>40 v</td>
<td>50 ma</td>
</tr>
<tr>
<td>80 v</td>
<td>28 ma</td>
<td>20 v</td>
<td>30 ma</td>
</tr>
<tr>
<td>60 v</td>
<td>40 ma</td>
<td>10 v</td>
<td>20 ma</td>
</tr>
</tbody>
</table>

Features and Key Specifications—Transistorized throughout (including the chopper), the Model 3821 is packaged on a 3" x 4½" plug-in etched circuit card together with the appropriate mating connector. Normally, the amplifier is shipped in open loop form. It can be connected to integrate, sum, invert, amplify, or differentiate.

Key Specs. Open loop dc gain: 2 x 10⁹. Drift referred to input: (a) at constant temperature, 100 μv/8 hours; (b) between -10°C and +55°C, 1.5 mv total drift; (c) between -55°C and -10°C; less than 2 mv. Integrator drift (1 μa and 1 meg) 500 μv/sec maximum. Power requirements: ±110 vdc nominal; regulated, ±150 vdc (bias level); 40 volts peak-to-peak at 400 cps center tapped for chopper drive.

For technical applications and information, write or call us here in Concord.

SEE US AT THE IRE — BOOTH 3829-31

*Patent Pending

Photo by William Slesan

±100 VOLTS AT 20 ma
50 ma AT ±50 VOLTS

DONNER
SCIENTIFIC DIVISION
SYSTRON-DONNER
Corporation
CONCORD, CALIFORNIA
THE WESTERN SIMULATION COUNCIL Committee on Uniform Specifications for Analog Computer Performance met at the La Jolla Beach and Tennis Club October 31-November 5, 1961. They are (left to right): R. D. Blosser (Autonetics), W. N. McLean (North American Aviation), J. E. Sherman, Committee Chairman (Lockheed, Missile and Space Division), W. Comley (Douglas Aircraft), and J. E. Reich (Space Technology Laboratories). The following representatives of leading analog computer manufacturers were also in attendance: E. Massell, W. Blanding, and D. Keane—Electronic Associates, Inc.; C. Single, M. Gilliland, F. Antonini—Beckman/Berkeley Division; J. Kennedy, R. Howe—Applied Dynamics, Inc.; C. Husick, S. Tetta—Computer Systems, Inc.; B. Loveman—Reeves Instrument Company.

### Pieces

WESTERN SIMULATION COUNCIL MEETING OF 14 SEPTEMBER 1961 ON COMBINED ANALOG-DIGITAL SIMULATION

Thanks to Dick Blosser, Autonetics (La Palma, Anaheim, Calif.) host for the 14 September meeting, we have received a copy of the fourth paper presented at that meeting—“Description of Combined Analog-to-Digital Simulation Facility” by J. M. Johnson Jr. (Autonetics).

Johnson on Combined Facility

By way of introduction the author states:

“Too properly analyze a digital flight control system it is necessary to perform combined analog-digital simulation studies covering all phases of system operations. Autonetics Armament and Flight Control Engineering has designed a digital control system for the MINUTEMAN ICBM missile and, as a consequence, has placed in operation a combined analog-digital computing facility. This facility is capable of handling 6-degree-of-freedom (DOF) trajectory simulation studies for each stage of the MINUTEMAN missile; provisions are also made for system hardware tie-in. The combined facility has been in continuous operation since November 1958. During this period considerable analog-digital simulation experience has been accumulated in solving a variety of complex control problems including 3- and 6-DOF trajectories using both rigid and flexible (four bending modes) airframe dynamics. Moreover, a complete 1st stage trajectory study has been accomplished using actual flight hardware.

“This report discusses the combined analog-digital simulation facility and includes a discussion of some of the problems encountered along with their solutions. As a prelude, the potential advantages of using a digital control system are discussed briefly.”

Before describing the Autonetics Combined Simulation Facility in detail, Mr. Johnson makes some remarks on the characteristics of digital computers which we will pass on verbatim without comment.

“The attractive features of a digital flight control system are briefly summarized as follows:

1. High degree of precision.
2. Improved reliability because of freedom from problems associated with electromechanical or electronic analog equipment.
3. Ability to perform logical as well as linear or nonlinear mathematical operations.
4. Sensitivity of component parameter drift minimized, thereby improving system accuracy; optimum system performance enhanced through the use of matched components inherent in digital computers.
5. Facilities for storage of large quantities of data that may be required in complex systems.
6. Decision-making and switching capabilities for control system readjustment readily obtained.
7. Shaping networks easily mechanized as difference equations, whereas the analog equivalent generally results in the use of large components.
8. Certain adaptive control techniques easily mechanized since network parameter variations are greatly facilitated by the use of difference equations.

Large Size and Complexity of Input-Output Equipment

“Recent developments have greatly minimized this problem. The advent of reliable, digitalized sensing instruments and the use of frequency-modulated pulse-train input-conversion equipment for analog sensing instruments has reduced the size and increased the reliability of input equipment. Moreover, progress has been made in the development of digitalized controller equipment, particularly hydraulic valves that operate directly on pulse train outputs.

Generation of High Frequency Noise

“Generation of high-frequency noise is caused by (1) the discontinuities
Introduction of the EASE 2100 series analog computers marks a major advance in computer control...the pinboard. A previous edition of SPEAKING WITH EASE described the pinboard and its advantages which we briefly restate here: it consolidates all control functions formally located on the patchboard and places them under the fingertips of the operator; it makes programming and checkout easier and faster; it offers increased flexibility; and it provides additional capacity on the patchboard for 50% more linear equipment (one pinboard hole does the same job as two patchboard terminals). We will now discuss the logic of the pinboard concept, and show how, in conjunction with a new idea in circuit design, it greatly simplifies computer programming.

Subsystem Transferences

It is possible to build an analog computer of simple building blocks in which programming instead of patchboard interconnection achieves the desired transfer function characteristic (transference). Thus, through a simple pin connection, a multiplier can have either a product transference (multiply) or a quotient transference (divide).

An example of this approach is the use of "current multipliers" where two inputs, \( X \) and \( Y \) in volts, are accepted and a current output, typically \( 10^{-8} \) XY amps, is achieved. The current output is patched to the grid of an operational amplifier to achieve the conventional voltage multiplier. With one meg feedback impedance, this output voltage is then \( 10^{-8} \) XY. This type of arrangement achieves astounding flexibility and maximum utility of equipment. The same current multiplier can be used with more complex patching to operational amplifiers and/or other similar current multipliers to achieve output voltages proportional to:

\[
X/Y, \sqrt{X}, \sqrt{X^2 + Y^2}, \frac{X}{\sqrt{X^2 + Y^2}}
\]

etc. But flexibility of this nature has certain disadvantages. Not only must the operator be more astute, but the approach

The unique Pinboard, an exclusive EASE feature, provides the operator with a powerful approach to the problem of computer control. The picture depicts a typical EASE Pinboard designed for a 2132 Computer; for the larger 2133 Computer the Pinboard is similar except that more of the unassigned terminals are utilized for controlling a correspondingly greater amount of computing equipment.

This illustrates the extensive amount of patching required to achieve vector composition (inverse resolution) on a conventional patchboard. This same transference is now achieved by inserting a single pin into the appropriate hole in the "NON LINEAR" section of the EASE Pinboard.

The circuit for the Inverse Resolution (X, Y input; R, \( \Theta \) output) is quite involved when seen on the patchboard of a standard computer (note example above), and many possibilities for operational error are inherent. In the 2100 Series Computers the same circuit is automatically achieved by insertion of a single pin (see upper right corner of pinboard). The complexity of the circuit is taken care of by one reliable relay. Voltage output multipliers are used, but their output amplifiers are appropriately connected so that they actually perform as current output multipliers for the Inverse Resolution Transference. The multiplier output amplifiers are used in place of any external amplifiers. Thus only + X and + Y inputs are needed to produce the desired \( R \) and \( \Theta \).

Pinboard—Key Feature

Now, how does the pinboard fit into all this? It is by simple pin insertions on the pinboard that the desired transferences are selected. Let’s take an example to illustrate the simplicity of programming under this new system.

To insures programming efficiency, a concept of easily pre-programmed transferences has been incorporated into the EASE 2100 Series Computers. The desired transferences are predetermined and relays have been added to connect the computer equipment automatically as determined by each transference. This saves operator time and avoids confusion since no complex patchboard wiring is involved. It eliminates human error and allows the operator to concentrate on the problem under solution, rather than on the clever use of computing elements.
contained in the output signal (e.g., if a zero-order hold output device is utilized, the signal form is staircase in appearance); (2) the truncations on finite resolution associated with digital process, giving additional amplitude discontinuities as well as a small dead zone at null; and (3) the roundoff process involved in digital computations, resulting in a low-amplitude random fluctuation of the output.

"Foldover" Effect

"This effect arises because a sampled system cannot produce a sinusoidal wave form above half sampling frequency.

Filtering

"If filtering is required above half the sampling frequency it must be accomplished by analog means."

Following a general description of the facility, the author goes into more detail under the following headings:

- Bendix G-15 Digital Computer
- Packard-Bell Multivertor
- D17 (a general-purpose airborne)
- Digital Computer
- Special Conversion Equipment
- Scaling Problems
- Noise
- Isolating Failures
- Computer Programming
- Start and Hold Both Computers
- Digital Program Checkout
- System Inadequacies
- Hardware Problems
- Digital Program Difficulties
- Studies Conducted

Mr. Johnson's presentation was interesting, and we're sorry that we haven't the space to include all details.

★★★

In the December issue of the Newsletter you commented on the confusion caused by two correspondents covering the same meeting.

An unfortunate case in point is that I only recently received a copy of the host's presentation at the July 10th meeting of the Midwestern Simulation Council at the U.S. Steel Corporation, Monroeville, Pennsylvania. This paper, "The Application of Control-Computers in the Steel Industry", was presented by T. R. Schuegger (U.S. Steel Corp.). As it was previously presented at the Pittsburgh Regional Technical Meeting of American Iron and Steel Institute on 16 November 1960, and is available in reprint form, we will only comment on it briefly here.

Schuegger on Process Control Computers

In the introduction the authors state that "Estimates* in 1960 have indicated a potential market for (process-control) computers of from $4,000,000 to $100,000,000 per year in 10 years. These are rather wide limits, but with the present rate of rise in customer interest, it is reasonable to settle on a figure of $20,000,000 to $30,000,000; and there is little doubt that an appreciable part of this will be spent by the steel industry. Again it must be emphasized that this sum is for computers only and does not include the devices that furnish their inputs and the units directed by their outputs."

The "present" (1960) status of process-control computers is then considered in detail, with descriptions and illustrations of many of the available models.

Under "Application Considerations" the authors state:

In the past, many systems have been made automatic by continually comparing the output to the desired value and making corrections automatically as required. These systems have been extensively applied to speed control, position control and temperature control. As the scope of the control system increases, there comes a point at which a simple comparison and logic function is no longer sufficient. This may be due to the fact that a relatively complex calculation may be required before a decision can be made on the necessary corrective control action. It is the control of such systems that are generally termed "computer control." Therefore, a computer controlled system primarily denotes a degree of complexity of control rather than a basically new concept.

Because most processes in the steel industry employ feedback control, whether the loop is closed by an operator or automatically, it is important that corrective actions be determined and executed in times that are short compared to the major delays of the process. This is important because the delays in applying corrective action should not substantially add to the inherent process delay and thus unnecessarily prolong any off-standard production. Therefore, computer control would evidently be indicated for consideration when the following process conditions prevail:

1. Complex calculations and decisions are required that exceed both the operator's capabilities and his ability to react sufficiently fast. In this case the loop would be closed automatically and would represent the greatest potential for computer control.

2. Complex calculations and decisions are required that exceed the operator's capabilities, but his reaction time is adequate if he has this information. In such a case the loop could be closed by the operator, but the overall feedback time delay would be substantially reduced.

3. A large number of simple comparisons and decisions are required, but corrective action must be made quickly.

4. A large amount of operating data and summarizing information is required for operational reasons.

Before a computer controlled processing system can be properly engineered, several basic requirements must be satisfied:

1. The availability of process equations that adequately describe the process.
2. The availability of instrumentation to measure the required variables of the system.
3. The availability of control equipment to perform the required control functions of the system.

Then after a discussion of process equations, instrumentation, and computer control equipment, the authors take up "Economic Considerations" and say:

When it has been determined that a process is adaptable to the refined automatic control that can be afforded by a computer, then it is desirable to look closely at the economic factors. The following are some of the major economic questions that should be analyzed:

1. Will there be less variability in the quality of the output product because of faster and more accurate adjustments to the process?
2. Will the production rate be increased by more uniform loading of the process equipment?

*Listed on the reprint as W. E. Coleman and F. Slamar, both of the Applied Research Laboratory, U.S. Steel Corporation, Monroeville, Penna.
3. Will maintenance costs be reduced as a result of better control of equipment loading?
4. Will conversion costs be reduced significantly by consistently establishing the desired combination of process variables?
5. Will the quality improvement resulting from the rapid availability of process data be significant?

Affirmative answers to one or more of the questions must be followed by an estimate of the benefits and this estimate must then be weighed against the costs of the computer control installation, including consideration of the auxiliaries required to make the computer effective. Not to be neglected is recognition of the fact that properly trained technical people must be provided to maintain the control system.

Although the foregoing quotations, when taken out of context, may be somewhat unfair to the authors' full treatment of the subject, they are offered as indication of the changing attitude toward control computers in a most important industry.

**SOUTHEASTERN SIMULATION COUNCIL MEETING OF OCTOBER 20 AT MARTIN-ORLANDO**

We conclude PIECES this month by passing on to you, just as received, all the information we have on the October 20th meeting of the Southeastern Simulation Council at the Martin Company, Orlando, Florida.

"The Simulation of Static and Frictional Force" presented by John Zampino (Martin Company, Denver, Colorado).

**Zampino on Friction Force**

Consider the spring mass system shown in Fig. 1. The following approximations are made:

a. The forces involved act through the center of gravity of the mass.

b. The static force to be overcome is equal to the frictional force.

The problem will be defined as follows:

1. For frictional force effect. If \( |kx| > |F_s| \), then \( mx + F + kx = 0 \).
2. For static force effect. If \( |kx| < |F_s| \), when \( x = 0 \), then \( F = -kx \), \( \dot{x} = 0 \), and \( x = C \).

The first part of the problem is solved easily as shown in Figure 2. Most problems involving coulomb damping are solved in a manner similar to this.

If the amplitude of oscillation is such that \( kx_{max} \) becomes of the order of magnitude of \( F \), then the effect of condition (2) becomes important to the proper solution. Fig. 3 provides a circuit which satisfies the requirements of both conditions. If the voltage into the limiter does not approach the limit value—that is, the force applied is less than the frictional force—then \( e_o = ke \), \( F = -kx \), and \( \dot{x} = 0 \). When the limiter limits, the force applied is greater than the frictional force, \( F \neq -kx \) and \( \dot{x} \) takes on some value. This voltage into the high-gain amplifier holds the limiter on limit except when \( \dot{x} = 0 \). A comparison of \( F \) and \( kx \) is thus allowed when \( \dot{x} = 0 \). If the limiter is not on limit, \( F = -kx \) and the motion ceases. If the limiter is on limit, \( F = \neq -kx \) and \( \dot{x} \) again takes on some value as a result of the acceleration.

A shunt limiter (not shown) around the high-gain amplifier is required to prevent overload when \( \dot{x} \) comes in. For proper operation, this limit must be above that of the series limiter. For good operation, the series limiter should not creep. Fig. 4 illustrates a limiter which will not creep. The resistance \( R \) should be as small as is practical; 10 or 20 K will usually be satisfactory. If \( F \) becomes small as compared to \( kx_{max} \), then larger values of resistance will probably be necessary to prevent overload of the high-gain amplifier.

Fig. 5 shows use of coulomb damping with additional forces involved.

**FIG. 1.**

**FIG. 2.**

**FIG. 3.**

**FIG. 4. LIMITER**

which does not creep.

**FIG. 5. ADDITIONAL forces due to coulomb damping.**
ANALOG TECHNIQUES

by THOMAS C. ANDERSON (Lockheed Missile & Space Co., Sunnyvale, Calif.)

MAXIMA AND MINIMA

The circuits shown in Figs. 6 and 7 were developed by Prof. G. A. Korn of the University of Arizona for the purpose of marking the time of occurrence and storing the values of relative maxima and minima of a problem variable.

In Fig. 6 the output voltage $X_o$ follows the input $X(t)$ as long as $X(t)$ is increasing. During this phase of operation diode $D_1$ is conducting, $D_2$ is not conducting and $D_3$ is conducting, which effectively grounds the summing junction.

When $X(t)$ reaches a maximum and begins to decrease, $D_1$ becomes non-conductive and $D_2$ starts to conduct. The feedback path formed through $D_2$ brings the amplifier output up to $X(t)$ very quickly, which changes the voltage applied to the diodes decisively. The step voltage produced provides the marker steps ($X_{max}$, $X_{min}$) which can be utilized in a variety of ways.

$X_o$ is a low-impedance amplifier output storing the maximum value of $X(t)$ until it is exceeded by a subsequent larger value of $X(t)$. When $X_o$ is exceeded by $X(t)$, a reverse step is produced at $X'_o$ and the circuit tracks and marks the new maximum.

Minima are marked and stored by similar circuits with the bias voltages and the sense of the diodes reversed.

The circuit of Fig. 7 is slightly more accurate than that of Fig. 6, which requires a low-impedance source. Since $D_1$ of Fig. 6 and both $D_1$ and $D_2$ of Fig. 7 are in the feedback loop of an amplifier, errors due to diode characteristics, distortions and off-sets are reduced by a factor of the reciprocal of the loop gain. Below 1 cps, errors are less than 0.05 volt and with frequencies up to 100 cps, the errors can be held as low as 0.2 volt.

Information (and Howe!)

We have a notice of a colloquium on *Techniques Modernes de Calcul et Automatique Industrielle* to be held in Paris, 29-31 May 1962. Unfortunately, the deadline for abstracts of proposed papers was January 15th of this year. However, further information on the colloquium may be obtained by writing the Comité d’Organisation, A.F.R.A., 19 rue Blanche, Paris 9e, France.

* * *

Bob Howe tells us that he and colleagues at the University of Michigan are again preparing to conduct one of their “Intensive Courses in Automatic Control.”

We are always interested in these courses because of the extensive use made of simulation equipment for demonstration and instruction. This year the dates are June 13-27. Bob’s address is Department of Aeronautical and Astronautical Engineering, University of Michigan, Ann Arbor.

Copies of your Ed’s paper, “Analog Computer Simulation of Heart Action,” presented at the Winter General Meeting of the American Institute of Electrical Engineers, are available on request to those interested in the use of computers for simulating biological functions.

Your Council also has a few more copies of “Proceedings of the Combined Analog/Digital Computer Systems Symposium” ($5 each) and the “Proceedings of the 1961 San Diego Symposium on Biomedical Engineering” ($10 a copy).

He Went Thataway!

Thomas W. Connolly to Control Technology Inc. Their news release refers to Control Technology as a “California firm” but fails to give any address.
REDUCED PRICES

Simulation Council Newsletter—Cont.

Letters

What's with Analog Computation? An equipment manufacturer answers the critics!

Dear John:

I was indeed delighted to hear of the recent move of the Eastern Simulation Council to form a council "Educational Committee" for the purpose of studying the problems of training industrial and college personnel in the applications of the analog computer. Such an undertaking is one that can be extremely constructive and one that, if followed through, will go a long way toward providing enlightenment about analog simulation where it is really needed—i.e. at the "grass roots" academic level. Three cheers to the ESC for initiating a move that has been needed within the simulation councils for some time—that is to pursue Bob Horowitz's move toward greater dissemination of the value of the lore established by these tightly knit and somewhat esoteric groups. I think it goes without saying that EAI will be delighted to offer any reasonable service to the ESC that will enhance the successful operation of this committee.

Much discussion has taken place of late concerning the future of analog computation and this discussion has entered last year's Western Simulation Council region. Perhaps this is justifiably so, since that region holds the preponderance of the initial users of general-purpose analog computers and, as such, contains many of the oldest and largest computers in the country. The real payoff problems being handled by these machines fall into a small number of rather similar categories and in many cases are largely the same as those done five or more years ago. I believe, engages in simulation council meetings, society papers, etc., that have a good deal of similarity between them. The panel involved felt that "there is no longer anything new in analog computation," and they look to the manufacturers of this equipment for "something new" in the way of applications innovation, hardware breakthrough, etc.

As you know, EAI has for a number of years maintained a formal training staff, the mission of which is to provide everything from basic primers to advanced applications courses in analog simulation to appropriate engineering groups throughout the country. Within the past several years, in many cases much to our surprise, we have found that (1) no organized training facilities exist throughout many of the largest analog-computer laboratories; (2) the design engineer with the "small to medium size" problem is spending considerably more time in the large of the many facilities. How many times have we heard the head of a large computer facility say, "We don't have any small problems anymore"; (3) new techniques that have been covered in professional meeting papers (IRE, EJCC, WJCC, etc.) are unheard of, or at least far from understood in many computer installations; (4) maintenance procedures sometimes leave much to be desired and preclude effective computer usage and results.

We at EAI are aware of the sizable educational task ahead of us and intend, as much as we possibly can, to continue investing our time, effort and dollars in scientific education during the forthcoming year. I sincerely believe, however, that without the strong support of the user groups, the success of the manufacturers in this effort will be at best a mild one. When situations as I outlined above exist in large computing facilities, nothing that a manufacturer can do is going to sell potential users within that organization on analog computation, since the analog computing facility within the organization is providing its own upper limit on growth.

If the management of that computer installation, however, would organize continuing training, we would sell simulation in a planned and hard-hitting manner throughout his organization, would program the small user into his facility knowing that one day he may be running large sophisticated problems, would keep his computer in tip-top shape, so that it is capable of delivering repeatable and believable results, and would explore constantly for new areas of application within his own organization, then I am certain that he would achieve significantly more results in expanding the use of simulation than he could by relying on anything that the manufacturer might produce for him.

Let me say a few words regarding Bob Horowitz' excellent letter to you in the December Simulation Council Newsletter. While we don't pretend to have done anything but scratch the surface in the field of bio-medical simulation, we have made some initial steps into this new activity with the area of application. Our Los Angeles Computation Center has done considerable work in bio-medical simulation for a leading research foundation; as result of having been so sponsored a three-day educational seminar on the subject—attended by medical doctors and research scientists throughout the northern California area. We intend to publish this work shortly.

In addition, we have recently sponsored a fellowship to provide a training program in analog simulation to a doctor of bio-chemistry from New York University. His training has now been completed and he is presently endeavoring to set up a similar program, sponsored by the National Institute of Health, which would be available to those in the bio-medical field on a nationwide basis.

Let me firmly reiterate what I have mentioned verbally to many of our Simulation Council members who have questioned me about the future of analog computers. EAI is firmly and completely dedicated to the concept that analog computation is basic to dynamics and thus, will always play an important engineering, as well as academic, role in the future. We intend to use our resources to the best of our ability to educate the vast element of the scientific world presently ignorant of
the power of simulation, and in so doing, come more closely to achieving our final objective—i.e., the widespread interest in and use of the analog computer throughout the entire scientific and engineering and, perhaps, even business community.

In closing, let me summarize what I meant to be a two-fold purpose of this letter. (1) That we at EAI are indeed aware of the educational problem associated with the expanded use of analog computers and will be doing all in our power to deal with it constructively in 1962. (2) That the large computer users (who are now questioning the future of the analog computer) can also go a long way toward making known the power of analog simulation. They can organize continued training activities, they can “sell” simulation in a planned and hard-hitting manner throughout their company, they can program the “small” user into their facility, they can keep their computer in tip-top shape, so that users believe the results and, even most important, they can be on the continual alert for new areas of application within their own organizations.

Many people are placing the onus of innovation and education on the manufacturer, but there are a lot more users than manufacturers—and no one can educate potential users and search for new applications within their own organizations more effectively than the existing users themselves.

Robert L. Yeager, Manager
Computer Product Sales
Electronic Associates, Inc.
Long Branch, N. J.

MEETING NOTICES

WESTERN S/C MEETING
March 8, 1962, 9:00 A.M.
Host: Aeronautronics, Newport Beach, Calif.

MIDWESTERN S/C MEETING
March 12, 1962, 9:00 A.M.
Subject: Systems Simulation
Host: Bendix Aviation, South Bend, Ind.

ROCKY MOUNTAIN and CENTRAL S/C JOINT MEETING
April 13, 1962
Host: Capt. Quirk, Air Force Academy. Speakers: Dr. R. M. Howe, Dr. George Bekey, Dr. E. DeLand, A. A. Barkauskas

WESTERN S/C MEETING
May 4, 1962, 9:30 A.M.
Place: Fairmont Hotel, San Francisco, Calif.

WESTERN S/C MEETING
Joint meeting with Rocky Mountain S/C
July 12-13, 1962, 9:30 A.M.
Host: Boeing Airplane Company, Seattle, Wash.

There’s a lot of magic in B & F servo components.

CIRCLE 108 ON READER-SERVICE CARD