The Simulation Council Newsletter

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Bits

Not much space for Ye Ed to put in his two-bits' worth this month—too much worthwhile stuff.

We have some goings-on at the International meeting in New York concerning "Computers of the Future," and E. G. Holmes' story of the Southeastern Simulation Council meeting on "Error Analysis" and the use of DDA's in connection with analog computers.

Then in "Information" a few words concerning the organization that makes this Newsletter possible and some "Allied Operations".

Western Simulation Council
Jock Sherman, Missile Systems Division, Lockheed Aircraft Corporation, Van Nuys, Calif.; Chairman, Steering Committee.

Central States Simulation Council
Jim A. Pierce, Beech Aircraft, Wichita, Kan.; Chairman, Steering Committee.

Midwestern Simulation Council
A. C. Robinson, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Frank Richmond, Glenn L. Martin Co., Baltimore, Md.; Chairman, Steering Committee

Southeastern Simulation Council
W. K. McGregor, ARO, Inc., Tullahoma, Tenn.; Chairman, Steering Committee.

Canadian Simulation Council
P. W. Pruden, National Research Council, Ottawa; Chairman, Steering Committee.

Pieces

REPORT ON FIRST INT'L S/C MEETING AT TIAE

Approximately 80 people attended each of the four sessions of the First International Simulation Council Meeting, held in connection with the Third International Automation Exposition in New York City the last week in November, 1956. Allowing for the fact that all people did not attend all sessions, total attendance must have been about 120.

The first session, Wednesday afternoon, November 29th, was conducted by the Midwestern Simulation Council. Talks and discussion on "Which Computer to Use—Analog or Digital?" will be written up by Bob Lowry, the Midwestern Secretary, and reported in the Newsletter when we get the word from Bob.

What Next in Analog Computers?

The second session, held later that afternoon, was conducted by the Western Simulation Council. Jack Sherman (Lockheed Missile Systems Division, Palo Alto, Calif.) presided while Ye Ed. (Convair-Astronautics) presented a paper by his absent colleague Stan Rogers (Convair-San Diego) entitled "What Next in Analog Computers?".

Stan's paper—too long to reprint here—was based both on a consideration of what is needed and a knowledge of what is being done. The increase in multishift operation, dictated by economic considerations, Stan believes, is going to exert a strong influence on the development of computers. Therefore increased effort will be devoted to the problem of removing, storing, reinstating, and checking out problems on the equipment quickly and accurately. This will require automatic setup and checkout, which in turn require some means of automatic patching, pot-setting, and checkout. Automatic pot-setting is well within the state of the art, and several systems of automatic checkout are reasonably satisfactory; however there are no satisfactory means for automatic patching within sight.

Stan feels that the system "should set up the complete problem virtually instantly; that is, it should be a parallel device rather than a perforated tape that has to be read serially. A very desirable form for problem storage would be something like a set of sheets of perforated paper."

It is likely that such mechanization will require some sacrifice of flexibility, but Stan calls for greater flexibility: "To make efficient use of a
large analog computer, the operating stations should not be of fixed sizes... it should be possible to control the required number of amplifiers, multipliers, comparators, etc., for one problem from one station. This means... that whatever is substituted for the patchboard should be of variable size... a large computer should have several operating stations... precautions will have to be taken to keep two operators at different stations from trying to use the same computing equipment at the same time.”

Stan predicts an increased use of “subroutines” to alleviate the conflict between convenience and complexity. A subroutine would select the components and make all connections to set up frequently-used circuits (as simple as a division circuit or as complicated as a set of standard aerodynamic equations). The operator then would be concerned only with connecting the inputs and outputs and adjusting the constants.

Also needed, Stan says, is some way of helping the operator with his scaling so that he can avoid both overloading and working too near the noise level. Sed Atwood (Convair-San Diego) has proposed a method of scaling with a CRT which will indicate these conditions, but a method of preventing or automatically correcting them is needed.

And, analog computers should be better suited for the solution of partial differential equations and the presentation of the results. “We believe that we at Convair are making progress,” but much is still to be done.

The marked trend to combined systems also should be considered, Stan reminds us. Therefore the analog computer of the near future should be planned to be compatible with analog-to-digital and digital-to-analog converters like the Addavertex.

“A final area,” said Stan in closing, “in which large developments should take place in the next two or three years is that of the generation of functions of two or more variables. What is needed here is a convenient method of setting up the desired function, good repeatability, and reasonably good accuracy and frequency response.”

In the discussion which followed Stan’s paper, Jules Lehmann (RCA Laboratories, Princeton, N. J.) disagreed with Stan on one point—that input-output devices should be parallel—and pointed out that 10 to 20 characters per second don’t take very long serially; the necessity for going to parallel operation doesn’t really seem to be there. He went on to say that a system RCA investigated for the Air Force had connection instructions stored on punched tape. Relays made the connections.

McLeod: “I understand that for any fair-sized computer you would have a barnful of relays.”

Lehmann agreed that you would. For 500 amplifiers there would be between 50,000 and 100,000 relays.

Ed Massell (Electronic Associates, Inc., Long Branch, N. J.) commented that a patchboard with a couple of thousand holes has a lot of possibilities. Equivalent flexibility might require several billion relays.

Jules replied that there is a certain logic you have to follow to reduce the hardware.

A. J. Zeichner (Sylvania Electric Co., Waltham, Mass.) wanted to know which multiplier Stan referred to when he wrote: “The newest electronic multiplying equipment that we have received appears to be clearly superior in accuracy and stability to some of our older equipment.”

McLeod ‘lowed as how it must be EA ‘cause ‘There are more EA people here than any other vendor!’

Changing the subject, Jack Sherman observed, “This question of using subroutines to set up frequently-used circuits brings up the question of when is it wise to use human labor instead of complicated automatic systems.”

McLeod asked, “Don’t you agree that in aerodynamic problems there is a great similarity in certain parts of the set-up?”

Jack: “If you are referring to a pre-wired computer like Typhoon, that is a different thing altogether. But the complications of an automatic system to wire a computer for various subroutines would become fantastic.”

Bob Howe (University of Michigan, Ann Arbor, Mich.) asked Bernie Loveman (Reeves Instrument Corp., New York, N. Y.) if he didn’t have a subroutine setup on the new REAC—some sort of plug-in units.

Bernie answered that they have plugpacks which eliminate some patchcords by interconnecting amplifiers with resolver inputs. Amplifiers are arranged on the patchboard so that this can be accomplished. They use the same system with multipliers.

Ed Massell, referring back to Jack’s question of when it is “wise” to use human labor, said that it isn’t the labor that we are worried about. The cheapest way to make two electronic connections is to have a guy who doesn’t know what he’s doing put a patchcord between two holes. The problem is to be sure he gets them between the two correct holes. What we should try to do is to arrange the patching of an analog computer so it can be done by trained monkeys.

McLeod: “I believe that while we have been talking about saving human labor, everyone has had in the back of their minds the fact that it is the humans who make the mistakes. So if we can cut down on the human labor, a byproduct is cutting down on the chances of mistakes. That is what we are really interested in!”

Bob Howe, referring to Stan’s multiple patchboard requirement, asked how you know, when you’re setting up ahead of time, whether the guy over on the next station might be wanting that certain amplifier or not.

Otis Updike (University of Virginia, Charlottesville, Va.) suggested, “You plug in ‘integrator’ and the circuit will pick a free integrator.”

Bob: “So, if they are all busy you get a busy signal!”

McLeod: “If a summer answers, hang up!”

Howard Hamer (Electronic Associates, Long Branch, N. J.) wanted to know if San Diego was planning to borrow equipment from Pomona via long distance line.

McLeod said they haven’t got to that yet, but he will work on it.

Lehmann asked about the Astronautics combined analog and digital simulation.

McLeod answered that they are preparing to use their extensive analog equipment with the IBM 704 for a rather complete weapon system simulation. There are several reasons for the combination. One is that they would probably need five 704’s to do the problem in real time in the same detail if they didn’t use the analog equipment. On the other hand, the digital equipment must be used because some parts of the simulation require great accuracy (e. g. the navigation problem). Equipment is divided up in general according to whether it is simulating analog or digital equipment in the real system.

Lehmann brought up the question of inaccuracies from the analog being fed to the digital computer for high-accuracy solutions.

McLeod said that is a standard question: “Why go to the digital computer with hum information? In this case you will usually find that they are using the digital computer to
The Patchboard Verifier

In answer to a question, Loveman described the Reeves patchboard verifier. You put the patchboard on a device which is practically a computer in itself. It starts at the upper left-hand corner and looks at the first hole. If there is a patchcord in it, it stops and scans to find the other end of the patchcord. It prints out first the connection where it started, and second the location of the other end of the patchcord. (It isn't fair to have a patchcord with more than two ends! — Ed.) The first connection is tabulated in black, the other end of the cord in red. When the verifier gets to the other end of a tabulated patchcord it goes on past so you don't have two readings on one cord. It takes a few minutes to scan a board of several thousand holes. The cost is about the same as a computer!

Each connection is identified by means of a code number, and check sums are computed for each problem setup.

On a more general theme, B. D. Bidne (Westinghouse Air Arm, Baltimore) then pointed out that using every element of the computer in a single problem could detect only gross errors, since buildup of tolerances would preclude obtaining answers with errors less than several times the maximum individual component errors.

Ed Massell then commented that the new Convair special patch panel would check out each amplifier with its associated computer network separately, by applying balanced and inverted voltages to pairs of inputs.

All the higher-gain inputs may be eliminated in groups, so that progressive output scans (with the automatic readout system) can be made at tighter accuracy tolerances. Similarly, multipliers and resolvers are checked individually in all quadrants.

Bob Howe described a poor man's method whereby you can pick up 98% of the errors by taking your road map—the computer diagram—and counting the number of inputs and outputs to and from each component. Checking this against your board only takes a few minutes. The difficulty is usually that you have patched in the wrong place; you catch this by finding, for instance, that you don't have enough outputs to amplifier number 15 and/or that you don't have enough inputs to amplifier 10.

Answering a question, Bob said a technique to take care of partial derivatives on analog computers is to take advantage of the fact that you have time available as a continuous variable, and you can integrate with respect to time. So when you solve the partial differential equation you preserve time as a continuous variable but approximate your derivative with respect to the spatial variables by finite differences. For example, if you are solving the partial differential equation which describes something like an aircraft wing taken as a beam, you split the beam into a number of discrete stations and write difference equations for the spatial derivatives. You end up with a system of simultaneous ordinary differential equations tied together with the proper cross-coupling terms. If the problem doesn't get too large this is a convenient way of attacking it.

Ed Massell said it occurred to him that the problem of presenting the solution of a partial might be nicely solved by the scope display described by Sed Atwood. The space variable is displayed along the x axis on the scope to give you a varying curve which can be photographed if you wish.

Bob Howe said that this has actually been done to look at the vibrations of a beam; you can see what appear to be snapshots of the beam at different times.

This meeting was followed by the annual highball party and there were two more "technical" sessions next day. But I will have to tell you about these some other time as this letter is getting too long, and there are other things which I want to cover this month.

SOUTHEASTERN S/C MEETING OF 5 DECEMBER ON "ERROR ANALYSIS"

Twenty-four representatives of nine organizations attended the Southeastern Simulation Council meeting at Georgia Institute of Technology in Atlanta on 5 December 1956.

Bill Bradley (Murphy & Cota, Atlanta, Ga.) the outgoing Secretary, opened the meeting in the absence of the outgoing Chairman, W. K. McGregor (ARQ, Inc., Tullahoma, Tenn.), and turned it over to the new officers, Chairman-elect M. David Prince (Georgia Tech) and Secretary-elect Edward G. Holmes (E. G. Holmes & Associates).

Richard Rimbach of Instruments Publishing Company was invited to describe the interest of the magazine Instruments and Automation in the Simulation Council's activities, and Fred Dixon (Georgia Tech) gave a report on the International Steering Committee meeting recently held in New York.

After this Dave Prince turned the meeting over** to the Program Chairman, William Bennett (Lockheed Aircraft Corp.).

*Summarized under Info.

**If they turn this meeting over a few more times they should appoint "ole wirlin' John Brown" as Program Chairman! — Ed.
man... here’s something!

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Johnson on Error Considerations in Analog Computers

The theme of the meeting was "Error Analysis." Bill introduced Bob Johnson (Georgia Tech), whose paper, "Basic Error Considerations in Analog Computers," classified errors arising from linear and nonlinear devices in analog computers. In his talk Bob brought out some interesting points:

The error introduced by a single resistor is due mainly to its noise, the ohmic variation from the nominal value, and the change in resistance with temperature. If we choose one resistor at random from a large lot, the ohmic error in this particular resistor will be constant, but the noise and temperature effect is time-dependent. The important point here is that the noise voltage is a high-frequency phenomenon with average value zero, whereas the temperature effect plus the ohmic variation is a low-frequency variation of average value not zero. Thus any integrating process will average out the noise, but will accentuate the static error.

The potentiometer contributes a slightly more complex error because of loading and inaccuracies in setting values.

Then there are the errors of summing amplifiers due to non-ideal gain, imperfect frequency response, phase-shift characteristics, and errors in the series and feedback resistors.

Integrators tend to accentuate systematic and static errors, but to decrease the error of time-variant functions such as noise. Because the error in the integrator output due to a static error in the input will be proportional to the length of integration time, it is possible to reduce this error by choosing a time scale which keeps the problem-run-time short.

Linear devices actually contribute only a minor part of the error in a computer solution. The greatest errors by far occur in the nonlinear devices such as multipliers.

The servo multiplier has a very limited frequency response, so where high precision is required the time scale must be selected to keep the frequencies low. Servo resolvers are subject to the same type of errors.

The electronic multiplier is capable of relatively high-frequency operation while maintaining reasonable accuracy. The time-division type can easily achieve one-tenth percent accuracy with a frequency response flat to 200 cps.

Diode function generators exhibit little inherent error, particularly if silicon diodes or reduced-filament-voltage diodes are used. The precision of the function generation is limited by the break points available and the character of the function. These errors have been treated in a paper by Howard Humar (Electronic Associates).

When using feedback techniques for implicit function generation the errors often add up in a peculiar manner. For example, if a one-tenth multiplier is used in a divider, then the percentage error due to the multiplier alone is equal to 10 divided by the denominator. When the denominator gets as small as one volt the error is 10 percent.

Error may be introduced also by an oscillating amplifier, rectified noise, or some other fault not easily detected. To make matters worse, these troubles often come up intermittently or only at one point in the course of a run. A technique found useful in several laboratories is to permanently wire an oscilloscope in parallel with the panel meter, so that any voltage being read on the meter is automatically displayed on the scope. Many times errors will thus be detected which would otherwise go unnoticed or be attributed to component tolerances.

Of course the best check on the overall accuracy of a computer solution is an independent solution obtained by hand or a digital machine. This is often impractical and sometimes impossible, so we must usually depend on estimating the errors in the building blocks and extrapolate the results to the final solution.

At the conclusion of Bob's paper Bill Bradley commented that a considerable source of error not mentioned is the readout device.

Bill Bennett asked about the errors caused by noise and hum, to which Bob replied that they are usually kept below 15 mv, but if rectified they may cause appreciable error.

"What is the hum output of a function generator?" asked Dave Prince.

Bob replied that they have relatively high peak-to-peak hum output; one that he is familiar with has 0.5 volt.

"Does anyone here use any particular patchboard technique to avoid high-frequency oscillation?" Bob asked.

Sam Robinson (Lockheed Aircraft Corp.) replied that he always uses 50µfd shunted across the output of the summing amplifiers.

Robinson on Differential Analyzers

Sam was the next speaker and presented a paper entitled "The Use of Differential Analyzers in Conjunction with the DC Analog Computer for Solving and Checking Differential Equations."

Sam reiterated that the best way to check solutions is to use another method. A Bendix Digital Differential Analyzer at the Georgia Division of Lockheed Aircraft Corporation (Marietta, Ga.) is used to check solutions obtained on analog computing machinery as well as on digital machinery. Bob then described the integrators and the fine points of the DDA.

Dave Prince asked whether it is possible to generate functions on the DDA, to which Sam replied: "You have several ways of doing this. The servo operations can be given the effect of diode limiting and cut in at various levels just like a diode function generator. It takes two integrators for each break-point, so a large number of integrators must be used. Another method is to plot your function as a silhouette on a graph and use a Photo-Electric Follower."

Bill Bradley asked if this reduces accuracy, to which Sam answered: "Yes, with this method you have analog accuracy." He then described a third method of generating functions using the tape-input machine, on which they feed the program into the machine. "After the information is in the machine we take off the tape and put our nonlinear function on it. Each time it comes to a break-point a new number is read off the tape which corresponds to the following slope. In this way you can use as many slopes as you wish."

Bill observed that this implied that you must have a tape reader.

Sam agreed, adding that it is part of the machine.

Bill: "This method only uses one integrator?"

Sam: "Yes, but only one function is generated."

Jimmy Pekas (Lockheed Aircraft Corp.): "I'd like to add that if you have several monotonic functions of time, you can put in as many as you want on the one tape, but if you have a reversible function then only one can be placed on the tape at one time."

Sam: "Right. If you want your forcing function to be repeated every
BERKELEY OPENS
ITS NEW
COMPUTER FACILITY

Beckman/Berkeley's new Los Angeles Computation Center, located at 305-307
Parkman Avenue, provides large scale computation service for West Coast
industrial firms and research institutions. The location is easily accessible
from all freeways.

Opening February 26, the center will feature Berkeley's all-new EASE* 1132
analog computer with its exclusive digital output-input translator system.

Consisting of two separate computers of 50 amplifiers each with associated
non-linear equipment, this center represents an investment of $250,000 by
Beckman/Berkeley. The two computers can be interconnected for solution of
large problems.

Operating in conjunction with Berkeley's computer center in Richmond, Cali-
ifornia, the Los Angeles facility will be used for rental service to industry, for
special demonstrations and for educational purposes.

The center's staff, directed by George A. Bekey, is available for consultation
on engineering problems, assistance in problem preparation, and computer
operation.

Inquiries regarding this center and the 1132 computer will be welcomed;
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time you run the problem, this forcing function may appear in several places in different shapes, and you can put on as many as may be desired."

Bill asked: "Would you sum up as briefly as possible the advantages of the DDA over the DC Analog Computer?"

Sam: "The biggest advantage is the repeatability and the accuracy."

Bill: "Is it easier to set up a problem on the DDA?"

Sam: "It is almost identical to setting up one on the DC Analog Computer."

Bill: "Speaking in analog terms, what would you say the bandwidth of the DDA is?"

Sam: "It is infinite."

Bill: "I mean in real time."

Sam: "I said that it is infinite because a true step function may be introduced at any time, since the computer may be stopped and started at a different level. However, it takes about one minute to oscillate to one sine-wave while producing three-place accuracy."

This discussion was followed by a round-the-table discussion on computer facilities in the Southeast. Plans were made to tour the Computer Facility at Lockheed Aircraft Corporation the following morning, December 6th, and Dave Prince extended an invitation to all members to visit Georgia Institute of Technology Research Laboratory and Analog Computing Facility on Friday, December 7th.

Bellanca Avenue, Los Angeles, the first week in April, the subject will be "Programming, Scaling, and Error Analysis for DDA." There will be a demonstration of the new "Litton 40" DDA. Further information from Stan Rogers, 3023 Alcott Street, San Diego. There is also a meeting planned for June or July, probably in the East.

**Thot (or is it)?**

Beware those that draw the line for they are Plotters!∗

∗Copyright available to digital vendors at a nominal fee.

**Computer Events**

Other events on page 224

**Western Joint Computer Conference**

Dates: 26-28 February 1957
Place: Hotel Statler, Los Angeles, California
Subject: "Techniques for Reliability"

**Third Annual High-Speed Computer Conference**

Dates: 5-8 March
Place: Louisiana State University, Baton Rouge, La.

**Western Simulation Council**

Date: 14 March 1957
Place: Research Branch, Missile Systems Division, Lockheed Aircraft Corp., Palo Alto, Calif.
Subject: "Evaluation of Computer Usage"

**Eastern Simulation Council**

Date: 22 March
Subject: Simulation of Nuclear Reactors
Time: 10:00 A.M.
Host: Alfred Gronner, American Machine & Foundry Co.

**National Simulation Conference on Computers—Southwest Regional Conference and Electrical Show, IRE**

Dates: 11-13 April 1957
Place: Houston, Texas

**Midwestern Simulation Council**

Place: Houston, Texas
This meeting will be held in conjunction with the Southwestern IRE Conference and Exhibit at the Shamrock Hilton Hotel on 11-13 April.

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**INFORMATION (Without Theory)**

All who are not interested in the modus operandi of the Simulation Councils can skip the next two paragraphs. However, some have indicated that a brief résumé of the decisions of the various Steering Committees is in order. So — —

At the New York meeting of the Steering Committee of the International Simulation Council it was decided that:

1. We would publish the Simulation Council Newsletter in Instruments and Automation for at least another year.

2. The Midwestern Simulation Council, which advocates private publication, would appoint a committee to study the matter.

3. We would investigate the practicality of holding our annual informal meeting in conjunction with the formal Joint Computer Conference (which already attempts to consolidate the computer interests of the IRE, AIEE, and ACM so that there are fewer rather than more national meetings in our field).

4. We would draft Dr. R. M. Howe of the University of Michigan to be Chairman of the Steering Committee, International Simulation Council, for 1957. *

At the 10 January meeting of the Steering Committee of the Western Simulation Council it was decided that:

1. We should get on the ball with a more active permanent (one year!) Steering Committee, or the other Simulation Councils would leave the founding chapter in the lurch.

2. The present officers (Jack Sherman, Chairman; Dow Abramis, Vice Chairman; Joe Hussey, Secretary-Treasurer) should remain in office till July.

3. The Steering Committee should be composed of:
   - Past Chairman (Norm Irvine)
   - Present Chairman (Jack Sherman)
   - Vice Chairman (Dow Abramis)
   - Secretary-Treasurer (Joe Hussey)

3. We would investigate the practicality of holding our annual informal meeting in conjunction with the formal Joint Computer Conference (which already attempts to consolidate the computer interests of the IRE, AIEE, and ACM so that there are fewer rather than more national meetings in our field).

4. We would draft Dr. R. M. Howe of the University of Michigan to be Chairman of the Steering Committee, International Simulation Council, for 1957.

**In the May Nucleonics magazine there will be a special report on the use of analog and digital computers in nuclear design. Further info, Dan Cooper, Nucleonics, 330 West 42nd Street, New York 36, N. Y.**

**We received an announcement that our long-time friend Lee Cahn, formerly of Beckman Instruments, has formed the Cahn Instrument Company for the design, manufacture, and sale of scientific instruments in Downey, California (Office at 7712 Danvers Street, Laboratory and Plant at 11408 Brookshire Avenue). Good luck, Lee!**

It is tentatively planned to hold the next DDA Council meeting at Ramo-Wooldridge Corporation, 8820