Camarillo, California

Third Simulation Council Newsletter

January 1953

Well folks, as promised, your Newsletter went to the National Bureau of Standards' Corona Laboratory Symposium on Analog Computation. Dropping the formal editorial technique so beloved of most publications, I'll get to the point and say that whether or not your Newsletter went, at least your secretary and three of five members of the Steering Committee did. 16 other organizations were represented by some 52 additional visitors.

Your secretary and this member of the Steering Committee were late. We tried to cut across Los Angeles traffic "in the morning before it got bad". We missed. When we came in, Mr. Wadel of JPL had spoken and Mr. Presson of that Laboratory was apparently presenting a very good talk on the subject of analog solutions of various boundary layer conditions. Unfortunately, your editor could not catch up with the presentation, and quite frankly probably would not have understood it if he could have. Anyone interested in the subject is referred to Arthur Presson, Jet Propulsion Laboratory, California Institute of Technology, Pasadena.

The next talk, however, we did understand, perhaps because it was a continuation and an expansion of the subject discussion at the last Simulation Council meeting. Don Leggett of Douglas Aircraft Company, Santa Monica, told us things about function generators that I wish I had known before. Maybe Don expressed it differently, but here is what I got out of it: (1) Don's analog group is placed in a position of competition with digital computers. (2) This competition is concerned with total elapsed time, i.e., setup time plus solution time. (3) Each type has advantages (as if we didn't know). 1 (4) The setup time for a given problem may be approximately equal for the first setup, after which the analog will probably have an advantage in solution time. (5) If the problem is one which must be "stored" and set up at some later time, the repeated analog setups will probably take longer than the digital ones, with the result that the digital method will usually have an advantage. (6) For that reason, Don and Company are devoting a good bit of productive effort to the development of better ways to store analog problems. (7) One of the main problems is to store and regenerate arbitrary functions. (8) Don and his coworkers at Douglas have investigated five kinds of function generators: Reeves input drums, Reeves cams, Reeves electronic function generators, multi-tapped pots, and diodes. (9) They have gone all out for the multi-tapped pots. (10) Don has prepared an excellent paper on the subject, including equations for calculating the value of the padding resistors and of the scale factor, a method of handling functions with maxima and minima.

1 It is my personal opinion that, because both analog and digital techniques have peculiar advantages, the ideal simulation equipment can evolve only with the cooperation of the two schools of thought.
and of moving the tap positions on the curve. The complete paper is beyond the scope of this Newsletter, but Don has offered to furnish copies to those interested enough to write us.

After Don Leggott's excellent talk, Lee Cahn of Beckman Instruments spoke on the subject of "Analog Computer Applications to Process Industries". Lee opened with the remark that analog computers are divided into two types, the "simple" ones in industry today and the others that we usually think of, the so-called "general purpose" computers. He explained that he would not have much to say about the former; that his talk was concerned with the latter type. Then Lee proceeded to give the most complete exposition on the subject of industrial controllers in the fewest words that it has been my pleasure to hear. And that takes in some territory. I have been granted several patents on industrial controllers embodying proportional integral and rate response, but I listened with interest as Lee explained what I had been doing. Anyone wishing more information on this subject is referred directly to Lee Cahn, Beckman Instruments Inc. (not me!)

After this succinct introduction, Lee got down to the real subject of his talk, the application of general purpose analog computers (like the Beckman EASE) to the solution of the complicated problems created by the application of automatic controllers to industrial processes. These problems are different from those encountered in the stabilization and control of aircraft or guided missiles in that they are usually concerned with regulation; as Lee put it, "no one wants to maneuver a petroleum refinery!" Nevertheless, the problems can be very complex, because they may be concerned with completely independent systems as well as the usual cross-coupling effects found in aero-dynamics. Therefore it is often impossible to determine the proper equipment and parameters for optimum control of industrial processes without applying analog techniques. Examples of the application of these techniques are explained in detail in "Application Bulletin 1" and "Application Bulletin 3", which can probably be obtained from the Beckman Instruments Company direct or through your Newsletter without begging too hard.

Following Lee Cahn's talk, Professor Walters of UCLA presented a detailed analysis of some regenerative loops in computing machines. He emphasized this effect with respect to analog computers, where it is often troublesome. He showed that these regenerative loops may occur when elements of the physical system being considered are coupled through an element capable of storing energy. He showed that the regenerative loop gain is the critical factor, and presented an analysis of the effects of varying this gain to stabilize the computer without a significant loss of accuracy. Details of the analysis are beyond the scope of the Newsletter, but his conclusions may be of considerable interest to users of analog computing equipment. They are as follows:

1. Investigate the physical system, if possible, for coupling through energy-storing elements or for the presence of elements which cannot store energy independently of other elements in the system.

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2 Between my work with the Taylor Instrument Companies and Leeds & Northrup Company, your editor was in the industrial control field for some seven years.

3 Berkeley Scientific Division, 2200 Wright Avenue, Richmond, California. Attention: C. E. Jones

4 Dr. Walters was kind enough to furnish us with a copy of his complete paper, and would probably be willing to do the same for anyone interested enough to contact him directly or through this Newsletter.
2. If such coupling exists, set up the equations for the system on both the loop and node basis. One may lead to a stable computer solution. This applies equally well to mechanical, electrical and thermal systems.

3. If an energy-storing element persists in increasing the order of more than one of the simultaneous equations describing system behavior, investigate the interchange of parallel elements (loop basis) or of series elements (node basis) as a means of obtaining a stable solution.

4. If none of the above suggestions succeed and a unity gain regenerative loop must be employed, introduce a small amount of attenuation in that loop. The amount allowable without threatening the validity of the end result is governed by the shift in the systems roots as well as the magnitude of the transient introduced in the higher derivative terms. These must be assessed for the particular problem being studied. Often as much as ten percent attenuation is allowable.

Dr. Bennett of Hughes Aircraft followed Dr. Walters with a discussion of the application of the weighting function concept, wherein impulses applied at some past time appear with values added during the time elapsed since that input. Such techniques can be used to calculate miss-distance as a function of a disturbance taking place at some previous time, or at some certain range, or other similar problems. The usual straightforward approach requires that a large number of runs be made with the disturbing function introduced at a different time in each run. Bob explained a method they use for automatically plotting such information in one operation of an analog computer. The computing elements are reversed in order, i.e., inputs become outputs and time runs backwards, with the result that in the suggested missile-target application the missile would start at the target and back up to the source. He attributed this method to Lening and Battin of MIT, who have published a paper on the subject.

The second subject of Dr. Bennett's talk was their method of recording instantaneous values of interest, such as for instance, miss-distance. They do this by picking off values at the instant of interest and storing them in any convenient way, such as a charge on a condenser in an analog computer. The stored information is then read by a plotting board which is caused to draw a small circle around the point by application of small out-of-phase sinusoidal biases on each axis of the plotting board. This is very convenient when making many runs of a single problem wherein the system is influenced by noise.

Al Fulton then told of the work of his laboratory at Hughes where he, like many of the rest of us, is busy extending the work of the analysts to the more complex or time-variant non-linear systems. One problem of interest is to close the loop around an airborne digital computer now being developed. This will involve an analog-digital conversion at the input to the digital computer and a digital-analog conversion at the output. This is interesting to the Newsletter, because the techniques which they must develop to accomplish this will be directly applicable to the combining of analog and digital equipment for the solution of many other types of problems.

There followed a group discussion of the facilities of the various organizations represented, and the scope of their work. Unfortunately, for security reasons we cannot discuss the projects described, and the equipment of the various facilities is similar. However, Dr. Olds of Inyokern drew an appreciative chuckle when he said he liked their Sanborn Recorder because they didn't go home at night.

5 A discussion of this is contained in "Theory of Servomechanisms"; James, Nichols, and Phillips.
speckled with various colored inks.

Greenwood of Lockheed seemed to be more familiar than the rest of us with the type of computers that have been variously called AC, or passive network, or otherwise, and made interesting comments on their use and characteristics. Burnside of North American mentioned a portable console which was of interest to many of us, and which we look forward to inspecting when North American is host to the February meeting of the Simulation Council. Don Leggett set the assembled crowd back in their seats laughing, with the shortest answer of the day when, replying to a serious question as to whether he did not expect difficulty in combining actual missile components with Electronic Associates, Goodyear, and Reeves computing equipment in a single closed loop, he answered simply "No".

Probably the most interesting non-programmed talks were those by Stan Rogers and Dov Abramis of Convair describing their new installations at San Diego and Pomona. They apparently are in the enviable position of having had enough experience to have a well thought out plan, and then having the opportunity to start from scratch and carry it out. Their 200-amplifier double console remotely-controlled installation sounds like what many of us dream about. However, we are not going to repeat Stan's and Dov's description, but are going to go out and take a look for ourselves when Convair, Pomona is host to the Simulation Council in March. We promise you a real story, with diagrams if possible, in your March Newsletter.

After lunch in the NBS cafeteria, McVey of Hughes was telling of systems involving a human being in the loop. He explained that they were always interested in evaluating the system, not the human operator. This caused Dr. Skramstad to remark that MIT researchers are feeding the human operator one, two, three, four, and more shots of alcohol and then evaluating him. Want a job at MIT?

At the conclusion of the discussion period Dr. Bennett announced that the Corona meeting would be the last one sponsored by his group; that it and their previous meetings had been held to fill an obvious need, but that with the increasing number of people interested in analog computation and simulation, organizing and conducting the meetings had become too much of a burden. He recommended that all present join the Simulation Council, which he believes will fulfill all their requirements for an informal exchange of information. He then introduced John McLeod, Chairman of the Steering Committee of the Simulation Council, to explain the operation of the Council.

That's me, so I told them roughly what I have told you and written to you before. I explained that "participate" was a better word than "join". The Council has no initiation fee, no dues, and no membership lists, so you cannot join in the usual sense. However, without sufficient participation the Council will cease to exist. You can participate by coming to the meetings and joining in the informal discussions of simulation problems, and/or you can subscribe to the Newsletter for six dollars a year. Or you can send interesting comments or questions to the Newsletter. None of these ways of participating is contingent on any other. However, the more you participate the more you can profit. If you join in all our activities you should really learn about simulation! And you will help us accomplish our objective: "To increase the effectiveness and broaden the application of simulation".

Dr. Skramstad thanked Mr. Lansman, head of their Systems Analysis Unit, for his good work in conducting the meeting, and by way of introduction to the tour of the laboratories, told how the Bureau of Standards happened to be in the guided missile business.
It seems that back in the early part of World War II, while Dr. Skramstad was with NBS in Washington, they were requested to turn their talents to the development of a guided missile system. They collaborated with the Radiation Laboratory at MIT to develop two of the early ones, one of which was the only guided missile to be used successfully by our forces in that war. This set them up in business, and in 1945 they built the first complete simulator, which included an analog computer, a flight table, and a simulated target with three degrees of freedom. Later when the Reeves Instrument Company made analog computers available commercially, NBS augmented its equipment with some REACs. With progress, the guided missile group became crowded in Washington and decided to move to the West Coast in line with the policy to disperse Government agencies; because quarters were available at the Naval Hospital in Corona; because the West Coast is the center of the guided missile business; and because of the proximity to the two Naval test ranges at Point Mugu and China Lake.

Corona Inspection

After the meeting the visitors were divided into two groups to inspect the NBS facilities at their Corona Laboratory. One group was conducted to the Simulation Facility while the other was taken on a tour of the other facilities. Unfortunately most activities we saw came under some security classification (for this reason the meeting was Confidential), so we are not able to give any details. However, we can say that the work of the Laboratory is diversified, and that they are apparently progressive in many fields (understatement of the week).

More on Function Generators

Bernard Benson of Benson-Lehner Corporation writes that while we were grousing about the imperfections of available function generators at Truman's Restaurant last month, "four units with these problems somewhat solved were standing but a garlic bread's throw away. We built the first 16-inch tube arbitrary function generator over a year ago, and have just completed a small production run of four for the Air Force. The 8" x 8" masks can be cut with scissors or razor by hand to accuracies good enough for most purposes, namely 1.0%. One of these will be in the Western Computer Conference, February 4 through 6."

Subscriptions

We are sending personal notes of appreciation to all those who have subscribed, or have indicated that they intend to and asked us to bill them. To all others we would like to say:

1. This is a non-profit effort to improve simulation techniques and equipment.
2. We have already received subscriptions and other support sufficient to assure our operation through 1953.
3. If there are reasons (6 bucks or any other) why you do not care to subscribe, you are still welcome to our meetings if you are interested in simulation. If you contribute to the discussion to the extent that your name appears in the writeup, you will be sent a free copy of the Newsletter covering that meeting.
4. Contributions of information suitable for inclusion in the Newsletter are also requested from non-subscribers as well as subscribers. Contributors will be given by-lines and sent a free copy of the Newsletter in which their material appears.
5. Single copies, or additional copies of any issue of the Newsletter can be ordered for 50¢ each. Unfortunately, this applies also to copies of issues originally distributed free, because it requires that we go back and run them off especially for you.
Demonstrations Requested

Limited past experience of the Council has indicated that demonstrations of equipment at meetings can be both interesting and profitable. We therefore encourage them, so why don't you get in the act? It is preferable that these demonstrations have some relation to the subject of the meeting, but not necessary. If your equipment can be used in simulation, let's see it! The Steering Committee realizes that it might be embarrassed if someone wishes to demonstrate his equipment in his competitor's plant. However, this should be interesting, and we'll try to see that no one gets hurt.

February and March Meetings

The North American Aviation Company at Downey will be host to the February meeting of the Simulation Council. The meeting, at which MULTIPLIERS will be discussed and demonstrated, will begin at one o'clock on Wednesday, 18 February, in the Personnel Building. No security clearance will be necessary for the meeting, but clearance through Confidential will be required for the inspection of the Simulation Facility, and higher classification may be required for discussion of individual projects. Therefore everyone interested in attending the meeting is advised to start arranging immediately for clearance through the highest classification to which he is entitled. I need not remind most of you that there is some very interesting work being done at North American, and that generally speaking the more interesting the work the higher the classification.

The same security situation will probably prevail for the March meeting of the Simulation Council, which is scheduled for the Convair plant at Pomona. This should be a very interesting visit, not only because of the size of the installation (some 200 amplifiers), but also because they have not bought any standard equipment. They have taken standard components of various makes and integrated them to be operated entirely from either or both of two remote consoles. This I gotta see!

Other Meetings of Interest

Messrs. Johnson, McRuer, Zacharias, Newhouse, Weinborg, Van Valkenberg, McCormick, Carr, Hendrix, and others are to present papers at the Seventh Regional Conference of the IRE at the University of New Mexico in Albuquerque, 26 and 27 of January, which will probably be of interest to readers of the Newsletter.

The RDB is sponsoring a symposium on the application of information theory to guided missiles under the auspices of JPL, Cal Tech, on 2 and 3 February.

The Joint Computer Conference Committee of the Institute of Radio Engineers and the American Institute of Electrical Engineers has scheduled the first meeting of the Western Computer Conference at the Hotel Statler in Los Angeles for 4, 5, and 6 February.

Notice

If we do not receive six bucks from those of you who have not already sent in yours, or at least some indication that you intend to subscribe (better you should send the six bucks), this may be your last issue of the Newsletter. We are not getting mercenary (perish the thought), but unless we hear from you we must assume that you are not interested (perish that thought too).
Security

It has been the two-fold objective of the Steering Committee in arranging meetings of the Simulation Council to (1) Have a general discussion of a selected subject; and (2) Visit a simulation facility. Whereas in the past we have hoped to and in some cases been able to accomplish both of these purposes without requiring any security clearance, a pattern seems to be shaping up for future meetings. It seems that we will usually be able to find meeting places and discuss simulation techniques and equipment without requiring any security classification, as long as specific projects are not mentioned.

On the other hand, it is obvious that security clearance will be required to visit many of the simulation facilities. It is therefore suggested that for ALL future meetings security clearance through Confidential be obtained by all who can do so. Those who find this difficult or inconvenient will probably be able to attend the meetings but may not be able to participate in the inspection of the facilities which we hope to hold in connection with all meetings.

Remember

Your Newsletter cannot hope to tell you how to solve your difficult simulation problems. We will, however, endeavor to create an environment better suited to the solution of these problems by improving communication.

We will not publish technical papers, but we will publish discussions and give references to stimulate interest in such papers.

We neither produce nor use simulation equipment, but we can contribute to the improvement of both equipment and techniques by giving manufacturers an opportunity to tell and show what is available, and allowing the user to say how he thinks it can be improved or put to better use!

QUESTION??

1. Do any readers know anything about the application of simulation techniques to the solution of reliability problems?

It would seem that such a versatile tool might be able to contribute to this very important study. In fact, we have an unexplored concept of the use of simulation to determine optimum component tolerances based on cost, weight, and complexity vs. the overall performance of the system. If you have any ideas, even half-baked ones, please write your Newsletter.

2. Do we have any readers who are interested in or have any knowledge of the application of simulation techniques to fields other than the ones we are usually yacking about? How about inventory control, merchandising, etc?

Note! If readers have any questions, we will be glad to see if we can get answers for you. There will be no charge for this service, even for good answers.

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