Simulation Council Newsletter

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December 1954

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COMING EVENTS

Eastern Simulation Council

Date: Monday, 17 January 1955

Place: Project Cyclone Computer Laboratory, Reeves Instrument Company, 215 East 91st Street, New York 28, N.Y.

Time: 1330

Subject: The topic of discussion will be Partial Differential Equations. Project Cyclone will start the meeting by describing some of the work they have done in this field.

National Industrial Conference Board Seminar

Date: Tuesday, 18 January 1955

Place: Sheraton Astor Hotel, New York City

Subject: "Personnel Aspects of Automation"

American Management Association Seminar

Dates: 20–21 January 1955

Place: AMA Center, 330 W. 42nd Street, New York City

Subject: "Practical Aspects of Automation"
Institute of Aeronautical Sciences

Date: Wednesday, 26 January 1955

Place: New York City

Subject: Annual Meeting

Symposium on Instrumentation for Process Industries

Dates: 26-28 January 1955

Place: School of Engineering, Chemical Engineering Department, Texas A & M College, College Station, Texas

Subject: "Instrumentation for the Process Industries"
For information write the Engineering School at Texas A & M.

Fourth Annual Instrument Short Course

Dates: 27-28 January 1955

Place: Los Angeles Harbor Junior College, Wilmington, California
For information write J. R. Wilson, 640 Fillmore Street, Fillmore, Calif.

Engineering and Management Course

Dates: 31 January - 11 February 1955

Place: University of California at Los Angeles, California
A class in Automation is scheduled.

Pittsburgh Chapter - Systems and Procedures Association of America

Date: Tuesday, 8 February 1955

Place: William Penn Hotel, Pittsburgh, Pennsylvania

Subject: "The Automatic Office"

High-Speed Computer Conference

Dates: 14-16 February 1955

Place: Louisiana State University, Baton Rouge, Louisiana
For information write J. S. Levinson, Department of Physics, Louisiana State University
Western Computer Conference

Dates: 1-3 March 1955

Place: Statler Hotel, Los Angeles, California

Subject: "Functions and Techniques in Analog and Digital Computers"
Pre-registration fee is $2.50, which covers admittance to lectures and exhibits and a copy of the transactions. The exhibit will be limited to the products of manufacturers of computers or major computer sub-assemblies and will be open during the day and evening hours. Besides the technical sessions and the exhibit there will be evening field trips to major Los Angeles electronics firms, a cocktail party and luncheons. For information write William Cunning, Conference Secretary, International Telemetering Corp., 2000 Stonor Ave., Los Angeles 25, Calif.

Technical Societies Council of New Jersey, Inc.

Date: Monday, 28 March 1955

Place: Essex House, Newark, New Jersey

Subject: Annual Conference - "Automation Conference"

National Conference on Aeronautical Electronics - IRE

Dates: 9-11 May 1955

Place: Biltmore Hotel, Dayton, Ohio

Invitation is extended to participate in the technical program by recommending papers and authors. Suggested topics, among others: Electronic Instrumentation; Computers, Theory and Application; Information Theory; Visual Data Presentation; Flight Control; Power Plant Control; and Design Bonors.

BITS

This month, gentlemen, (do any ladies read this sheet?) your "Bits" have gone to "Pieces". Jim Stone did such an excellent job of reporting the Battelle meeting of the Midwestern Simulation Council that your Editor is printing it practically verbatim, thereby leaving room for little else. Hope our readers who wanted more "heat" will sink their teeth into this - and thank Jim.

PIECES (Meeting of the Midwestern Simulation Council)

The second technical meeting of the Midwestern Simulation Council convened at Battelle Memorial Institute, Columbus, Ohio at 1:00 P.M. on 18 October 1954. Chairman Bob Hawo (University of Michigan, Ann Arbor, Mich.) called the meeting to order and Bob Heinster of Battelle welcomed the members of the Council on behalf of the Institute.
Chairman Howe reported for the Steering Committee that Bob Lowry (now of Bendix Aviation Corp.) had resigned from Goodyear Aircraft and from the position of Secretary for the Council. Charles Morrill (Goodyear Aircraft, Akron, Ohio) was asked and agreed to finish Bob's term as Secretary. Likewise, Gunther Martin resigned from Ford Motor Company (now with Schlumberger Instrument Co.), and Ford was asked to appoint someone to fill his position on the Steering Committee. Grant Snyder (Ford Motor Co., Dearborn, Mich.) took Gunther's place at this meeting.

It was announced that the February meeting of the Midwestern Council would be held at the Ford Motor Company.

The technical discussion concerning "Function Generators" started with a short talk by Jim Stone (Battelle) on "Smooth Curve Function Using Diodes". He described a method of using conventional, diode-type, function generators for the production of smooth curve functions rather than the straight-line segment functions normally produced by such circuits. A high-frequency "twitching" signal is added to the normal input signal and modifies the input current as averaged over a cycle of the "twitching" voltage. A filter in the feedback of the associated operational amplifier removes the twitching frequency and causes the function produced to be proportional to this average current. The modification of the function depends upon the magnitude and waveform of the "twitching" signal but not to an appreciable extent upon its frequency. A square wave signal results in an increase in the number of straight-line segments comprising a function. A triangular waveform, or a sawtooth waveform, causes the original line segments to be connected by a square-law curve. A sinusoidal waveform lies between that resulting from the rectangular waveform and that resulting from the triangular waveform.

Using the square-law curve produced by the triangular, a parabolic function generator was described using only two diodes.

The magnitude of the twitching signal employed at Battelle varied from 1.5 volts to 50 volts, depending on the particular application. The frequency of this twitching was approximately 10 kc.

Wolfgang Braun (Wright-Patterson Air Force Base, Ohio) asked whether Jim Stone had discussed this method in a paper at the National Airborne Electronics Conference in Dayton last May. The answer was yes. Mr. Braun then suggested that the square-law curves be utilized to construct a multiplier using the 1/4 square difference technique. Jim mentioned that this had been done, using four diodes and one amplifier, to generate products in four quadrant with reasonable accuracy.

Charlie Edwards (Bendix Research Laboratories, Detroit, Mich.) asked for an explanation of how additional line segments were produced by square-wave twitching. This was done by showing how the average current varies with the input signal.

Bob Howe wanted a statement of the accuracy of the method. Jim estimated this to be in the order of 1%, or equivalent to that obtainable with conventional diode function generators.

Charles Morrill wondered if the "twitching" method would work satisfactorily for functions with many different slopes. Jim stated it should and also suggested that different "twitch" signals might be employed in the various parallel input networks of the conventional function generator.
Bernard Loveman (Reeves Instrument Corp., New York, N.Y.) asked if the original difficulty due to the discontinuities in the derivatives of the function produced without twitching could have been caused by a mismatch of the line segments at the junction points. The answer was no since the manner in which the function was produced did not involve joining these segments end to end.

Charlie Morrill asked if the results shown by slides were obtained with sinusoidal or triangular twitching. Jim replied that sinusoidal twitching was used. Charlie then wanted to know whether better results would not have been obtained using the triangular twitching. Jim said not in this problem.

Charlie Edwards observed that twitching was similar to "dither" as used in hydraulics to linearize systems.

Harold Koppel (Bailer Meter Co., Cleveland, Ohio) asked if the results varied with the diodes used, and were selenium diodes employed in the computer at Battelle. Jim answered that no comparison had been made between diodes, and that selenium diodes had not been used.

H. F. Neissinger (Reeves Instrument Corp., New York, N.Y.) mentioned that Bell Telephone Laboratories had worked on a principle similar to the twitching in order to produce square-law curves.

The second talk was given by Jim Butler (Goodyear Aircraft, Akron, Ohio).

Jim described two function generators in use at Goodyear. The first, called the T-1 input-output table, consists of a drum positioned in accordance with an input variable, and a moveable carriage carrying a pen holder. As a recorder, this carriage is moved in accordance with a second input voltage. For curve following, and function generation, a resistance card and pickup replaces the recording pen and nickel fingers on the plastic cards contact a conducting line drawn on the drum. The carriage is then servo-controlled to keep the cards on the conducting lines. The error signal is added to the signal representing the carriage position to produce the output function. Jim showed the performance of this curve follower in following a curve composed of 1/4 inch steps.

The second type of function generator, the N3E, was a conventional, diode-type, function generator. Jim explained the operation of this circuit, showing how the N3E can produce either two sets of 5-line segments for two independent functions or a set of 10-line segments for a single function. The maximum slope of any single line segment is 4 volts output per one volt input.

Jim mentioned calibrating procedures and suggested that a quick way of setting up a function was to draw the desired function on a sheet of graph paper, place this on the T-1 recorder, and adjust the N3E until the function produced coincides with that desired.

Jim illustrated that more than 5 non-zero slopes in a function can be produced with 5 diode circuits by adding line segment in the middle of other line segments. As an illustration of this method, a full cosine curve which was produced at Goodyear was shown with an accuracy of 1% of full scale and with only 5 line segments being employed.

Bernie Lovern wished to know if Goodyear aged the diodes, type 6L5's, and why this type of diode was chosen. Jim said they did use aged tubes and that the choice of tube type was made for convenience since the 6L5 was employed in other units in the computer.
Charles Single (Westinghouse Atomic Power Division, Pittsburgh 30, Pa.) asked if any information was available on the frequency response of the servos used in the T-1. Jim said it was a high frequency. The carriage operated at a rate up to 10" per second as a recorder and up to 5" per second as a curve follower.

George Brown (Bandix Products Division, South Bend, Indiana) asked for comments regarding the drifts in diode function generators. Jim mentioned the use of stabilized amplifiers in the W33 and showed a graph prepared by General Electric of eleven runs under different conditions and times in which the maximum deviation was in the order of 0.1%.

Allen Albert (Chrysler Corporation, Detroit 31, Mich.) asked whether production-line 6AL5's were used. Jim said yes, but they were aged and tested. Allen asked if semi-conduction diodes were used. Jim said they have used them to generate special functions. Charlie Morrill said the biggest limitation of these diodes is the capacity across them.

Lt. Alfred Robinson (Wright-Patterson Air Force Base, Ohio) described and discussed the operational aspect of a special type of photoformer developed for Wright Field by Armour Research Foundation, Chicago. This device uses an opaque card with a black surface on which the function is drawn in white. The spot of light from a cathode ray tube is focused on this surface and the reflected light is detected by photomultiplier tubes. By this method, functions could be produced by means other than the photographic process normally employed in photoformers. Four photomultipliers are used to get sufficient output from the reflected light. One difficulty encountered in using these devices was in keeping the photomultipliers functioning properly. Second, difficulty has been experienced due to drift in the deflection amplifiers for the cathode ray tube. The deflection circuit is magnetic. Thus, a high-power d-c amplifier is required which is difficult to stabilize.

On the whole, this equipment seemed a bit on the unreliable side. Besides the d-c amplifier drift and the trouble with photomultipliers, the system was sensitive to line voltage variations and the linearity under ordinary use couldn't be held to better than 2 or 3%.

James Kouba (Chicago Midway Labs, Chicago, Illinois) said that he worked at Armour on those photoformers and wished to make one correction. Four photomultipliers were employed to balance the pickup of light over the entire plate and not necessarily to pick up enough light. He confirmed the problems encountered with drift and d-c offset and mentioned a meter which could be connected into the circuit for monitoring this.

Bob Howe asked for comments regarding tapped potentiometers, with either padding resistors or assorted voltage sources, as function generators.

Kouba gave three advantages offered by them. (1) They can produce a function and multiply a variable by this function; (2) the functions produced are repeatable; and (3) they can be used to generate more than one function of the same independent variable by using more than one typed potentiometer on a single shaft.

Hans Karlssinger (Reeves Instrument Corp., New York, N.Y.) mentioned that tapped potentiometers are one of the few types of function generators that can be used to produce a function of several variables. Functions of one variable may be coupled to the taps and the potentiometer interpolates between taps in accordance with a second variable. This method is called the "brute force" method and will
probably succeed in producing the desired result.

Charlie Edwards described a means of generating a secant function by the use of a loaded linear potentiometer. This method is similar to a technique described in MIT Radiation Lab series, but a second potentiometer was employed to correct for the errors inherent in the loaded potentiometer method. This second potentiometer is ganged to the first and produces a secant function over a range of 60 degrees which was accurate to approximately 10%.

Charlie said 1 kc was the carrier employed in the analog system with the Bongix high-performance flight table. He described the need and the use of the secant function in this system, and a means of establishing voltages for use in setting up a tapped potentiometer. A low impedance voltage divider, composed of 100 2-ohm resistors, established voltage levels in increments of 1% of the supply. These connected to a grid structure on which sliders picked up the desired level for each tap on the potentiometer.

Braun suggested that if an amplifier is employed in establishing the voltage at the tap on the potentiometer following the one being adjusted each time, the setup procedure moves pretty fast. By this means, the setting of one tap is established without later adjustments affecting it.

Charlie Edwards said that the low-impedance resistance network was thought of as a means of establishing voltage levels which would be less expensive than amplifiers. The impedance level of the divider must be small as compared with the tapped potentiometer. If amplifiers were used, and the inputs were a function of one variable, then the output would be a function of two variables.

Bob Howe said that a constant current source was one convenient way of setting up a tapped pot, and also there was little need these days to calculate the necessary resistors since there are means of easily setting them up without calculations. If a reverse slope is required, an amplifier must be employed.

Charlie said that amplifiers could be used to drive the low-impedance grid but that the amplifiers would need considerable power. Bob Howe stated that 100 volts across 200 ohms would be sort of fun!

Charlie next described a contour map which has been employed to generate functions of more than one variable. A model is constructed of \( f(x,y) \) such that the height of the model represents the value of the function. This model is placed on an \( x,y \) plotting board and a pickup on the carriage couples to an output potentiometer. If a function of a third variable is impressed across the potentiometer, this would be a function of three variables.

This map is first constructed of wood and then molded with some stable material for use on the plotter. Hoessinger said that the material used was dental plaster, he thought. Charlie further said this system gave an accuracy of about 0.1%.

The unit cost $40,000 and three of them were built and are in use.

Someone said that function generators were not clearly named. This contour map was called a three-dimensional function generator by Charlie Edwards and a two-dimensional function generator by others. This function generator permitted the generation of a product of an input voltage times a function of two variables. It does not permit the generation of \( F(x,y,z) \). It is a generator of a function of two variables and the multiplication is an added versatility of the instrument.
Bob Howe agreed with the definition. At this point in the discussion.

Following the break Bernie Lovenen spoke about a special function generator for generating the tangent of an angle. This technique appeared in the first issue of the RE2O Newsletter. A potentiometer is used as the impedance network for an amplifier. The arm of the pot connects with the input grid of the amplifier, one end connects to the output of the amplifier, and the other end connects to the input signal. In addition to the potentiometer, two equal resistors connect the pot ends to the pot arm. If the arm of the pot is moved in accordance with the angle concerned, the ratio of the output to the input approximates the tangent of the angle. This circuit produced a tangent with an accuracy of 0.2% between 13.5 degrees to 85 degrees. The maximum output of the amplifier was 100 volts, so that for angles in excess of 45 degrees, the input voltage had to be lowered to prevent overload.

Bob Howe said this was a good and economical means of generating a function. He then described a function generator for two variables which has been used at the University of Michigan. This method employed a sheet of conducting plastic upon which were constructed conducting lines. The impedances of the lines were much lower than that of the plastic and were used to establish equipotential lines representing fixed values of $F(x,y)$. A probe positioned on the surface in accordance with $x$ and $y$ would pick up a voltage proportional to $F(x,y)$. Since the potential distribution across the plastic sheet satisfies Laplace’s equation between the conducting lines, a well interpolated result was obtained. Bob also described the use of 6 or 8 of these generators in setting up a dynamic representation of a turbo-jet. Furthermore, if the variables $x$ and $y$ satisfy Laplace’s equation, it is necessary only to establish the potentials at the boundaries. The accuracy of this method is limited by the uniformity of the plastic and is approximately 3 or 4%. This may be improved by the use of a large number of lines to several tenths of a percent.

Bob did not know of any difficulty experienced with the probes in this equipment.

Hilt Warshawsky (Wright Air Development Center, Ohio) said that Mosesley used a probe which did not contact the surface but rather depended on the induced voltage in a pickup coil from an rf current in the conducting line.

Bob agreed, but pointed out that the coupling was from one variable and that the probe output was a measure of the deviation from the conducting line.

Someone stated that the output of the Mosesley probe was fairly linear over about 1 inch.

Someone else asked what material was employed for the conducting sheet and what material for the equipotential lines.

Bob was not sure, and suggested that the University of Michigan group be contacted directly. He thought the sheet was made from a graphite suspension. The lines were made with silver paint.

Lt. John Froggatt (Wright Air Development Center, Ohio) said they had been working with the Teledolites paper and a function generator like that described by Bob Howe. A three-pronged probe was used to measure the $x$ and $y$ gradients, which were
analogous to air velocities. The Teledeltos paper employed was the Type L and has a resistivity of approximately 2,000 ohms per square. The silver ink was procured from General Cement Company and, in the manner used, gave a resistance per line of about 3 ohms. The main problem is with the voltage pickup from the probes. The maximum voltage is about 1 volt, and there is quite a bit of noise associated with it. This noise appears to be associated with the roughness of the paper. This problem was alleviated by a 2 meg, 50 microfarad filter, and running the problem very slowly.

Bob Howe stated that the three-probed technique was used at the University of Michigan. This technique was used in the solution of problems involving the trajectories of drops in the flow of fluids around various contours.

Jerry Kennedy (Electronic Associates, Long Branch, New Jersey) told of experiments which they had carried on, using conducting glass manufactured by Corning Glass for panel heating. This material seemed to wear well, but he didn't have much additional information concerning it.

Elmer Gilbert (University of Michigan, Ann Arbor, Mich.) suggested that the leading effect of the probe end of noise generated by the current in the contact could be reduced by the unloading techniques employing amplifiers and regenerative feedback.

Bob Howe mentioned that Link Aviation had used a three-dimensional function generator. This circuit used tapped potentiometers and apparently was monstrous but reliable.

Lawrence Rauch (University of Michigan, Ann Arbor, Mich.) described a system of using a straight-line segment function generator with a photoformer to correct this representation of this function. The method worked quite well, with the photoformer contributing no more than 10% of the function.

H. W. Vessely (Chicago Midway Lab, Chicago, Ill.) suggested the function generators described up to this point were based on physical laws and resulted in "cams" of some sort. He suggested the generation of functions of a number of variables by the use of mathematical laws. While it is not always possible to express a function of two variables as a product of two functions of a single variable, it is possible to express a function of two variables as a sum of products of two single variable functions. By use of a set of orthogonal polynomials in x and y, this scheme resulted in 6 decimal place accuracy for e^xy when 5 terms in each polynomial were employed. This was an analytical check of the proposed method. The choice of the functions employed varies with the function to be produced, some converging more rapidly than others for specific applications.

Charlie Morrill asked the group for other applications where functions of more than two variables were necessary.

W. K. McGregor (ARO, Inc., Tullahoma, Tennessee) mentioned the air flow through valves as a function of upstream pressure, downstream pressure, temperature, and area as being a function for which they need equipment.

Klausinger said that typical aerodynamics problems involve functions of angle, altitude, and Mach number and also functions of more than one variable are needed in the study of radar-beam patterns.

Bob Howe summarized the situation at present by stating that no equipment exists for the simulation of these functions, and the end result is approximations to the desired result.
Jim Butler and Bob Have mentioned the multiplication of two or more functions of a single variable as a technique being employed.

Leissinger described a technique employing diode function generators for generating functions of more than one variable. By this method the input and the diode bias voltages are treated as variables. Use of multiple input networks in a single stage further expands the usefulness of this method. A circuit was shown, with an example used to illustrate this method. Another method mentioned involved the use of a linear combination of functions of two variables which could be more easily produced to obtain one which would not be easily set up by direct means.

Bob Have asked for comments concerning a time-sharing scheme developed by Goldberg at RCA Labs as a means of function generation.

Braun said he had discussed this circuit with Mr. Goldberg, and found that the most difficult problem associated with this scheme was a multistable multivibrator. This method was discussed in a paper by Mr. Goldberg at the Second Typhoon Symposium.

The meeting then adjourned for a tour of the Battelle Laboratory facilities.

**INFORMATION (Without Theory)**

The Benson-Lehner cartoon in their 1955 calendar showing them trying to get things shipped out "before they are obsolete" is certainly typical of the computing field. Soon as if only last year we "modernized" our REC at the Naval Air Missile Test Center by changing from the old telephone-type punch cards to the removable punch-panels. Now Reaves is cut with a new type of board that looks like an improvement, but the price of the conversion kit, $1632, and the probability of early obsolescence make us wonder if we wouldn't do better to wait for one of the automatic or semi-automatic punching systems which are being considered.

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As mentioned, your Editor is scheduled to give a talk on "Computers in Automation" at the Louisiana State University High-Speed Computer Conference, to be held 14-15-16 February in Baton Rouge. Feeling I had little to say that had not been said before, I felt that I could make some contribution by seeking the opinion of writers and workers in the field, and of labor and management, and collating them for consideration and discussion by my audience. The response has been such that now I have too much to say!

As readers of the Newsletter will get it anyway, this is not incentive (in fact it may just possibly be a deterrent) to him themselves to Baton Rouge, so I will mention another: The New Orleans Mardi Gras is only 80 miles away and takes place the following week. So "y'all come on down."

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Our interest in computers in automation made us take special note of a question check list prepared by T....B. Engineers Inc., Milwaukee and Ogden Avenues, Chicago, Illinois which purports to show when a given company should consider automation and whether they are ready for automation. We would be interested in the response this firm of "Technical and Business Engineers" receives.

**THE PAYOFF**

A year's subscription to the Simulation Council Newsletter costs $10.00. Checks should be made payable to the Simulation Council, Box 731, Camarillo, California. *Mardi Gras Day is Tuesday, 22 February, but there will be big doings the preceding week and weekend.*