The
SIMULATION
COUNCIL

Newsletter

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Bits

This month we finish up the story of our three innocents (?) Abroad (Gene Grabbe, Max Palevsky, and Ed DeLand) as told to the January 8th meeting of the Western Simulation Council, and then present notes on the activities of the study groups of the WSC which met that same day. And as if this were not enough, we have Charles Halijak's story of the Central Simulation Council's meeting on February 2nd. Plus an Info and a Thataway.

Pieces

WESTERN S/C MEETING OF 8 JAN

We checked the tape recording of Eugene Grabbe's (Ramo-Wooldridge Corp., Los Angeles) story of his trip to Russia as told to the January 8th meeting of the Western Simulation Council and reported in last month's Newsletter, and noted a few comments which might be of interest and which were not in the writeup of his more formal Association for Computing Machinery presentation, on which last month's report was based.

Examples: There are probably four or five thousand Russian analog installations as compared with three or four hundred digital devices, possibly because the Russians say the Germans advised analogs for industrial control. (We have about five thousand digital computers.)

They use thyratire multipliers. Instead of designing equipment for a particular job they will, when possible, use existing components: e.g., they have 35-mm film transports so they use punched film computer inputs.

Instead of quality checking their magnetic cores they simply put extra rows and trays in their magnetic memories and don't use the bad ones.

All machine-tool computers are transistorized, some with telephone dial inputs.

They use soldered wire rather than printed circuits.

They do a great deal of copying, particularly in consumer goods, in an effort to catch up by skipping the R&D phase. This, however, means they are about five years behind in these areas.

They also copy U.S. publications (photo offset?) to the extent that many are said to have a greater circulation in Russia than in this country. Gene showed a photograph of a newsstand on which there were several recognizable copies of U.S. publications, including Instruments & Automation!

One Russian article on differential analyzers listed 22 references, 21 of them U.S.
Paperbound books selling for as little as 17c and dealing with math problems, Sputniks, space travel, and satellites are popular reading.

Bill Kindle (EAI Computation Center, El Segundo, Calif.) asked about the economics of computing equipment.

Gene replied that it is complicated. A typical plant has a quota and a cost to meet. A markup of 40% seems to be standard in industry, though this doesn't necessarily follow for consumer goods. They make good wristwatches for 27 rubles (approximately $2.70) and sell them for 400 rubles—an markup of nearly 1500%. This is one way of milking money back into the economy.

For an organization to get a computer they must put it in their budget and buy it at the 40% markup.

Asked whether there are restrictions on selling U. S. computers to Russia and the satellite countries, Gene said "Yes, I'm sure there are. In fact, the Russians were quite amused by this. "Why do you hand us the big market—China and all the satellite countries?” they asked. "Why don't you sell us things directly? If we really want to get them we can!"

Palevsky on Strasbourg Journées

The next speaker was Max Palevsky (Parker-Bell Computer Corp., Los Angeles, Calif.), who attended the Secondes Journées Internationales de Calcul Analogique in Strasbourg, France, and then toured around Europe a bit.

People from all over the world participated in the Journées. Max said, including the Iron Curtain countries (except China), Ed DeLand (Rand Corp., Santa Monica, Calif.), G. D. McCann (Calif. Inst. of Tech., Pasadena, Calif.), and Ro Faveur (Electronic Associates, Inc., Long Branch, N. J.) were the only Americans Palevsky remembered seeing. Yet all talks referred to American developments, talks, articles, papers, etc.

Max referred to the program, saying there were papers of two kinds, one by groups just starting on analog computers, and others who are further along and interested more in applications. The Japanese are interested in analytical work: determining the exact characteristics of components, etc.

There were a number of papers on analog work at the nuclear institute in Yugoslavia, despite the fact that the Russians are not attempting to keep techniques in satellite countries equal with their own.

In general, the lack of money in Europe leads to a great deal of very ingenious work which is not necessary here because of our more powerful computers. Europeans tend to be better grounded in mathematics than we, and blackboards are cheap! This leads to abstract and formalized discussions.

Papers on Digital Differential Analyzers were given by people from Italy and England, and by Max, at sessions which were well attended. Max knows of no continental development of DDA's, but the British are working on them, even more than we in some respects!

Two in particular are interesting. One, at the Royal Aircraft Establishment at Farnborough, has a 10-megacycle clock rate. It is a "next generation" TRIDAC simulator.

A group somewhat further along is that at AVRO. They have a prototype parallel DDA running on missile studies. They also have a pencil and paper design of the final one, which they are starting to build. They need it primarily for trajectory problems because of difficulties with the TRIDAC. There will be a number of digital components—input, output, function generators, etc. Both groups are building transistorized equipment, but a problem is getting hold of high-speed transistors.

Also present at the meeting were a number of Germans, mostly from Darmstadt, a center for computing techniques. They were out of business during the rapid buildup of analog techniques, many of which had originated in their own laboratory.

There was a delegation of Russians from two different groups, an operating one that builds computers and a second group from one of the institutes, probably controls. They wouldn't answer any question that was even vaguely military. Max wanted to know how they guide those gadgets they're putting up. He asked about the relative importance of analog and digital techniques in accomplishing the guidance. The guy looked blank and said, "That is a very practical problem. We at the Institute only deal with theoretical problems!"

The Russians have several special-purpose analogs built for oil-field simulation. They are very big, each one like a building. Max was told, each simulating a total field, an area 150 miles in diameter, and all of the wells, both extraction and injection. The Russians felt such a simulation would be impractical on digital computers; there is an extremely large set of partial differential equations with hundreds of boundary conditions which, they believe, would take weeks and weeks on a digital computer. One of these machines simulates as many as 750 wells, and 30,000 parameters can be set in. It is estimated that a gain of as much as 10% in total yield can be realized over a number of years.

The Russians also have a tremendous number of passive network analogs for machine-tool control which are operated by the machine tool operator. They constitute an important project.

Russia suffers from a shortage of railroad equipment, so improving efficiency is of paramount importance. For a couple of years they have been developing a computer to control trains. Into it they feed wind resistance, track conditions, and other factors which must be considered to optimize the operation. The parameter of greatest interest is time; Russian trains run on time! To accomplish this they successively approximate optimum solutions to optimize time (and fuel consumption) within boundary conditions such as speed limits on curves, etc. With this computer they expect to save something like 5 to 10% on fuel while carrying more payload. The computer is an almost completely ferrite digital device operating in parallel. This sounds like a parallel DDA, but it isn't. Max was told that it is an arithmetic computer which is not serial—he could get no further information.

Irwin Pfeffer was interested to note that Max said the Germans had passed up analogs to work with digital computers while advising the Russians to use analogs. Max explained that this seems to be a matter of East or West Germans, and of process or machine-tool control—which, whom do you ask and what do you wish to accomplish?

Gene volunteered that the machine-tool computer mentioned is very similar to the General Electric computer.
Diode Function Generators: A Comparison of Types

As we attempt to simulate physical phenomena with greater detail and precision, we find that nature is far less regular than the inquiring mind desires. Our integrators, summers and multipliers fail to create analogs of many unruly variables, and we must turn to the diode function generator for a close approximation of empirical fact. Of the many types of DFG's available none is optimally designed for all purposes. The prospective user must decide which characteristics are most important to him and be content with necessary limitations in other respects. Foremost considerations are faithful simulation, ease and speed of set-up and cost. Let's see how available DFG's compare.

Differences in Set-Up Time

The card-set DFG offers instantaneous set-up once the function has been coded. Holes punched in the card activate relays which connect resistances into the diode circuit to create desired slopes. Disadvantages are fairly high cost, difficulty in fitting many curves because breakpoints are located at fixed intervals along the X axis, and a possibility of uncorrected errors because the operator cannot easily detect an error in coding. Nevertheless, the rapid switching of functions can be very useful.

The automatic tape-set DFG provides rapid set-up along with greater accuracy and flexibility. One fully automatic model can be set-up from a typewriter or even a digital computer. Drawbacks lie in the great expense of tape logic equipment plus the fact that the initial set-up is difficult to check and requires careful programming.

Semi-automatic DFG's have all the advantages of fully automatic except that initial set-up, being manual, is more time-consuming. An advantage of manual set-up—not to be underrated—is that the operator can easily check the function for errors. Necessary tape logic equipment is much less expensive, though the installation still requires a digital entry system such as the DO/IT.

Pushbutton-set DFG's offer the same accuracy and curve-fitting abilities as semi-automatic models at far lower cost. Functions can be set-up fairly quickly (each breakpoint can be set with pushbuttons in a few seconds), but re-entering a function requires the same labor as an initial entry.

The DFG with manually set potentiometers is still a standby in analog computation. Its high accuracy, low cost and ability to generate varied functions have made it a favorite where lengthy set-up procedures can be tolerated. The slow set-up, its principal disadvantage, has been overcome in the recent EASE model pictured below by mounting potentiometers separately on plug-in modules which permit function change with the speed of card-set models. Costs rise with the number of spare potentiometer modules desired, but expense remains far less than the cost of automatic or semi-automatic DFG's.

The new EASE Model 1177 diode function generator and its mounting unit. Four plug-in function generators are contained in 8½ inches of rack space. For flexibility, each DFG channel contains ten breakpoints and uses standard inverting amplifiers from the computer. Breakpoints can be located in any quadrant, and high input impedance allows paralleling of several channels. Write for specifications.

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Mountainside, N.J., ADams 2-7600

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4914 W. Belmont Ave., Chicago 41
PEnnscola 6-5270

For more information circle 75 on inquiry card.

Beckman Instruments, Inc.
Richmond 3, California
March 1959—Instruments & Control Systems—Page 409
or vice versa. The Russians are also working on hydraulic logical elements and mechno-pneumatic devices like sine-wave generators. IBM has set up a laboratory in Zurich for digital research with European personnel. One project is to build a set of hydraulic digital components—hydraulic flipflops, etc.

DeLand on the Strasbourg Conference

Ed DeLand was next introduced and said he would give a short speech, then scared us by holding up reams of paper. However, it turned out to be a collection of literature picked up at the Strasbourg meeting. “Going to the conference was like a breath of fresh air for analog people,” he said. “I stepped back five years into an analog world!”

Ed said that the machines exhibited, except for one Japanese one, did not have replaceable patch panels. However, the components were well engineered, to as high specifications as ours. Some of the machines shown can be patched from front or behind; semi-permanent hookups can be made behind; changeable parameters can be connected in front. Printed circuit amplifiers are used in England. Ed agreed with Max that computer development in Europe is a distributed thing, as was in this country some years ago, with many independent groups independently building their own. There seems no way to bring all the effort together.

A very important machine in Europe now is the network analyzer with which they hope to simulate the tie-in of all electrical networks of the Central European economic bloc.

ThePACE computer was displayed, and was an outstanding center of interest because it had features unlike those of any other computer shown.

And a Dutch Company showed black boxes which take logarithms or, plugged in backwards, antilogarithms—handy little gadgets to have around the house!* Mr. Helbig (EAI European Computer Division) invited DeLand to be his guest for three days in Brussels. Ed considered the many admonitions about accepting gratuities, considered the price of rooms in Brussels, and accepted! He spent some time at the Fair, but was also interested in the 120-amplifier PACE installation at the EAI Computation Center. All of the equipment is replaced with the latest as it becomes available. They get problems from all over Europe, even though their prices for equipment rental and engineering services are comparable to those in the U.S.

Irwin Pfeffer thanked Lee Ohlinger (Northrop Aircraft, Hawthorne, Calif.) for the parking arrangements and luxurious meeting accommodations. Lee explained that he had tried to talk Northrop into treating the crowd to lunch, but was told they couldn’t afford to set such a precedent!* Study Groups

Your Ed. was not able to attend the exploratory afternoon discussion group session because Suzy and I had to drive back to San Diego to speak to the local section of the Instrument Society of America on “Instruments for Simulation”**. This was an unfortunate conflict of interests, because Irwin Pfeffer tells us the experiment was quite successful, and we certainly would have liked to be there.

As it is, I cannot report you in any detail because the notes which Irwin was good enough to collect from the discussion leaders are somewhat cryptic.

Analog Simulation Techniques

We gather that George Bekey’s group on “Analog Simulation Techniques” talked about the simulation of delays in relays with RC circuits; of hard limits and ideal diodes a la Johnson*; oned sided limiters; rate and position-limiting circuits; the generation of functions of large angles a la Howe*; the Reeves rate resolver, servos with stops removed, and multi-turn feedback pots.

They also talked about variable-frequency oscillators, feedback diodes, tangent circuits using one sine-cosine pot, derivative circuits, and function generation of both one and two independent variables.

Some coverage! What was decided? Address George Bekey at the Space Technology Laboratories, P.O. Box 45564 Airport Station, Los Angeles 45, Calif.

Multiplier Committee Reports

Duane Beecher (Hughes Aircraft Co., Culver City, Calif.) led the discussion of the Multiplier Committee of the Analog Computing Equipment Group (seven participants). This group first reiterated their purpose (to establish performance standards) and then considered the difficulties attendant on the measurement of multiplier accuracy. In general the accuracy of the measuring equipment should be at least ten times that of the multiplier. In addition there is a great need for better understanding on the part of the user as to what a multiplier will and will not do. Three-D error plots, as furnished by at least one manufacturer, are very useful in this respect. Multiplier specifications must be complete, otherwise a manufacturer can optimize the stated specs at the expense of unstated ones.

In conclusion, the group seemed to agree with Joe Hussey (Berkeley Division, Beckman Instruments, Richmond, Calif.) that the Multiplier Committee should issue a report presenting the findings to date and paying the way for the presentation of improved techniques as they become available.

Maintenance Techniques

Pete Sykes’ (Space Technology Labs) group on “Maintenance Techniques” included Warren Howard (North American Aviation), Ralph Wheeler (Lockheed Missile Systems Division Palo Alto, Calif.), H. T. Bigelow (Nortronics, Hawthorne, Calif.), Bud Hale (Convair-San Diego).*

*Lee did, however, make arrangements which were probably better than a “free lunch”: by entering designated lines in the cafeteria and identifying ourselves as Simulation Council members we were able to get delicious (really!) steak plates for 65c. In other ways too, the host’s management of this meeting was the best we have seen. There were signs at all major intersections within miles of the plant directing us to the Western Simulation Council, and there were Northrop employees at the plant entrance who directed us to reserved parking and to the registration desk, where there were others assigned to help us register, tag us, and escort us to the conference room.

**A plot to set up a demonstration of our heart and lung simulator. See I&I for January ’59, p. 18 (in case you hadn’t noticed). The girl is not Suzy.—Ed

*Clarence L. Johnson, “Analog Computer Techniques”.

Harold Ehlers (Autonetics, Downey, Calif.), Bud Schoenber (Aeroneutronics), Gil Gramza (Douglas Aircraft, El Segundo, Calif.), and Len Schulowitz (Hughes Aircraft, Culver City, Calif.). Pete’s notes also indicate that the subjects discussed were the usual ones of interest to those responsible for maintenance (performance standards, test boards, optimum extent of daily check, etc.).

DDA Techniques

Irwin Pfeffer (Space Technology Laboratories, Los Angeles 45, Calif.) led 11 people in a discussion of “Analog-Digital and Digital Differential Analyzer Techniques”, which he began with a description of the Space Technology Lab operation. Some other points brought out: A T-2V DDA was used in a Douglas plane for navigation computations in real time; the Naval Ordnance Lab would like to simulate kinematics digitally in real time. They have a Litton Industries DDA which they have not yet tied in, but they would like to gradually replace their analog equipment with it.

A request by Irwin for better DDA literature for analog people led to a discussion of the kind of problems done on analog computers as contrasted to DDA’s and some tutorial information on DDA’s, including an explanation of the difference in operation of serial and parallel DDA’s.

The discussion next turned to the subject of analog-digital, digital-analog conversion equipment and the speeds and accuracies required.

The GEVIC computer was discussed, the generation of sine waves and other functions on DDA’s was considered, and the discussion concluded with the suggestion by Warren Shepard (Litton Industries) that the next study-group session include a discussion of “Error Analysis of Sampled Data Systems”, which is in line with the subject of the March meeting of the WSC, “Simulation of Sampled Data Systems”.

Physical Simulation

Willard Uplinger (Pacific Missile Range, Pt. Mugu, Calif.) led the group on “Physical Simulation”. He defined the subject as the closed-loop tie-in of computer and system hardware, described the use at PMR of the Bendix flight table, and then passed the subject around the table. The Hughes contingent (Chuck Bertuch, Bruno Ulbrick, and Hans Meissinger) have used physical simulation mostly in connection with infra-red studies. They spent some time at the Kodak infra-red facility, but feel much more time is needed and that a facility at their plant would be desirable.

L. K. Koski (North American Aviation) said that they plan to use their Bendix flight table to study the damping system of the X-15 if they can get it to operate satisfactorily for the purpose.

Dick Blosser (Firestone Missile) said they used physical simulation for quality control and improvement throughout the Corporal missile contract. For this work they found it necessary to build special-purpose equipment to simulate the air-loads on control surfaces.

Solution Checking

Bill Kindle (EAI Computation Center, El Segundo, Calif.) led off the discussion of “Accuracy and Checking of Solutions” by describing static and loop-gain checks used at the EAI Computation Center. For the static checks they assume initial conditions for all variables, compute the voltages at all outputs from original physical equations, check these against values read from the computer, and correct any resulting deviations. They make the loop-gain checks by leaving all coefficients in a problem mechanization in algebraic form. Then the scale factors around all closed loops should cancel to unity. This is true for non-linear as well as linear loops. However, this is a diagram check, not a computer check.

Dick Seferian (Rocketdyne, Canoga Park, Calif.) brought up the question of specifying accuracy of solutions.

R. C. Schmidt (Beckman Instruments, Berkeley Div., Richmond, Calif.) and others discussed the relationships of accuracy to problem types and computation techniques. The concensus of opinion was that general specifications for solution accuracy are not feasible.

Paul Williams (Northrop Aircraft) said they use a static check procedure of applying initial conditions one at a time. Prior to inserting the initial conditions, tables are constructed showing the influences of each variable on every other one by inserting unit values (one at a time) for each, and computing the corresponding value of all others. This results in a large table which gives the voltage for all points in the computer versus integrator initial conditions. The table has many zeros.

ARE any new fields of computation opened up by the GPS High Speed Analog Computer?

YES, the statistical evaluation of the performance of systems perturbed by random noise can now be accomplished at high speed. With the system simulated on a high speed computer such that the solution is carried out several thousand times faster than real time, samples of a random variable such as the miss distance of a missile system can be taken at rates up to 50 per second. Thus, sample sizes of several hundred can be taken in a few seconds’ time.

GPS has a complete line of equipment to generate random noise for introduction to the system and to monitor the output. RMS values of random variables can be measured directly and complete probability distribution functions can be determined with statistical confidence in a matter of minutes.

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ANALOG COMPUTERS

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For more information circle 76 on inquiry card.

March 1959—Instruments & Control Systems—Page 411
Ken Dyda (North American Aviation) brought up the subject of dynamic checking; North American effectively combines static and dynamic checks by using the IBM 704 to compute the static check and a sample time solution. They then overlay the analog and digital solutions on a light table. The digital program includes various cases with different nonlinear coupling terms omitted. This technique is used primarily for aircraft dynamics. Ken estimates that 20% of the errors found in the time solution would not have turned up in static checks.

Information (Without Theory)

In our November issue of the Newsletter we reported that we had received a copy of a book on analog computers which, so far as we could tell, seemed to be a French Korn & Korn.

This elicited a letter from R. H. Scanlan (Schlumberger Well Surveying Corporation, Houston, Tex.) saying that he had spent some years in France and would be happy to review the book if we wished.

We wished, he did, and so here with Mr. Scanlan’s review of Le Calcul Analogique per Courants Continus:*

In this book Danloux-Dumesnils, professor at the National Superior School of Aeronautics, Paris, organizes the course of lectures which he gives at that institution. In his introduction the author protests almost vehemently in favor of the preservation of purely French terms in French analog computation work (as against the introduction of Anglicisms) yet he defends his own use of such un-French terms as “computer” and “computateur.”

The real subject of the book is analog computing by d.c. electrical differential analyzer techniques. However, the title implies greater generalities, and acknowledgment is made of the existence of other techniques, notably special-purpose machines such as simulators, and potential field plotting devices and their derivatives.

*Duod, Editeur, 92, Rue Bonaparte, Paris.

After what are essentially opening bars and/or amenities, the book settles down to a rather explicit exposition of its basic subject matter. It is a fairly straightforward course and certainly a potentially valuable one to newcomers in the field. The following are the chapter headings: I Mechanical calculation. II Principles of electrical computing. III Components and accuracy of the computer. IV Solution of linear algebraic systems. V Linear differential systems. VI Operational language and compound operators. VII Non-linear calculation. VIII Special calculating machines. IX Area of application of analog calculation.

Those chapters dealing more directly with the mathematics and techniques appropriate to the electrical differential analyzer are certainly the most valuable of the book. The chapter on solution of simultaneous equations by analog methods appears to the reviewer to present weak and rather ineffectual means when compared to those now offered by digital computers.

Although a number of specific analog machines are cited, the book deals with principles and generalities, not details of analog computer construction. The level is that of a senior or elementary graduate course in engineering. It would be of value to readers of French, but this reviewer would suggest a revision of subject matter should translation for the English-speaking public be decided upon—particularly with the air of eliminating elements not important to d.c. differential analyzer type computing.

He Went Thataway:

Tom Connolly (formerly with the Princeton Computation Center, EAI) to the Marine Division of Sperry Gyroscope in Syosset, New York.

Computer Events

Central Simulation Council
Date: 11 May 1959
Place: Kansas State College, Manhattan, Kansas
Subject: “Non-Linear Control Systems”

For further information write Charles Halijak at Kansas State College.

Central Simulation Council
Date: 5 October 1959
Place: McDonnell Aircraft Co., St. Louis, Missouri
Subject: “Computer Administration, Environments, and Physical Facilities.”

For more information write Bruce H. Estes, Department 666, McDonnell.