It's Been A Goodyear But We're Tired!*  
(48 participants representing 25 organizations met this month.)

Len Stilwill of Goodyear Aircraft, our host for the day, opened the November meeting at the Goodyear Tire and Rubber Company plant by explaining that he was sorry the Aircraft Company didn't have any local facilities, but that "their subsidiary", the Tire and Rubber Company, had kindly offered theirs. Len said that in addition the Tire and Rubber Company was going to serve refreshments after the meeting, offer those interested a conducted tour through the tire plant, and give everyone present a free tire. They did too - only the tire is a little small for my car wheels!

After Len's welcome John McLeod called on Bob Bulami to open the discussion of Noise by describing some of his work in the NAHHC Simulation Laboratory. Bob profoundly observed that the main difficulty was to find a correct procedure to follow. The NAHHC people are simulating a complex weapon system in which a human pilot tracks a target, and are interested in how his errors, which are in the form of low-frequency noise, affect the system. It might be assumed that the best approach would be to record the existing noise and inject it into the simulation. Bob says that although they have done this to some extent, they are limited by the equipment available. They are also afraid that, since it is statistical, using the same noise over and over may lead them astray. So they have tried making frequency analyses by autocorrelation, Fourier series, and direct filtering. For the autocorrelation data was manually reduced and tabulated, then computed on IBM equipment. Next the autocorrelation was transformed back to the power spectrum by curve-fitting. More recently the RAYDAC has been used; it is extremely fast. This suggested the use of the Fourier method, because although the computation is more complicated, the RAYDAC is so fast that the difference is not significant. The Fourier series checked the results from autocorrelation pretty well and is preferred by the engineers, who seem to have more of a feeling for it. In another method some high-pass filters were used to get a rough idea of what the noise was. Bob said that although this is a crude method, it is possible to run through 20 or 30 pieces of information in a day, whereas it takes a couple of weeks to obtain the data, get set up, run the RAYDAC, and get back solutions.

Most of the information comes from gun-sight cameras, so they have developed a film tracker. This device projects the film at 1/16 the speed at which it was taken, a man manually tracks the target, and the information is converted to an

*We had to get a plug in for our host!
electrical signal to be plotted on paper or transcribed on tape. For the tape recording a pulse duration ratio system is being developed, with response from DC to 10 cycles which can make time base changes of a ratio up to 64 to 1 without distortion of the signal.

Three methods are used to obtain noise: a noise generator, groups of sine waves added together, and reduction of actual tracking information.

The random noise generator is of the conventional gas diode type similar to that described in Dr. Bannett's report, having a response from 1/3 of a cycle to 6 cycles. The NALTC people are only using it up to 2 cycles, for which region they have run an autocorrelation which indicates that it is pretty flat. The Reeves photoformer, used for introducing the actual noise, is only capable of scanning a 30-second sample, so it is necessary to sweep it continually. This hasn't worked too badly, but the use of this very short piece of information is questionable.

Bob ended with two questions. (1) Many servo systems have a response similar to a second order low-pass filter with a damping coefficient of about 0.5. This gives a rather smooth response curve with not very good frequency resolution, so Bob suspects that using random noise may be unnecessarily sophisticated. They tried to check this by first putting in three sine waves and then injecting random noise to represent the spectrum. Comparing the results statistically indicated that they apparently belonged to the same population. Is all this effort to generate random noise therefore unnecessary? (2) How much information is required for good results?

These questions opened the meeting for discussion of Bob's comments in general and questions in particular.

Norm Irvine (Aerojet) asked about the frequency of the second order system having a damping ratio of approximately 0.5. Bob replied that the system under consideration peaked at about 1/2 cycle. Dannback (Convair-San Diego) said that whereas the combined sine waves might have worked satisfactorily with the particular system under study, he questioned the application of this technique to other systems. Jack Hallinckhrodt (Ralph Parsons Co.) pointed out that one type of system for which this almost surely would not work would be an overall system in which were minor loops that were more sharply tuned. In this case perhaps almost zero power would be getting into these loops. Another thing Jack wondered about was the amplitude distribution curve and the effect of non-linearities in the system. Dick Baum asked if we were concerned with such small amplitudes that the system is fairly linear. Bob replied yes, but that sometimes the noise would get into the non-linear amplitudes and cause trouble. He went on to say that if in a Fourier series n is the highest significant harmonic, \( \frac{1}{\sqrt{n}} \) is proportional to the error to an order of magnitude or better.

Bennett pointed out that another consideration is time; even though you take an infinite number of selections from a short sample, you won't get an accurate presentation. Buland replied that they do have very short samples -- therefore they used many of them. Bennett observed that this reduced the problem to how many samples and how large a value of n per sample -- that statisticians have worked out fairly simple relationships for the length of samples and the number of samples for a given accuracy. Buland said yes, this was true, but that the NALTC statisticians shied away from the problem because they questioned the basic accuracy of the Fourier series. For instance, there is only one sine wave of the lowest frequency in the length of the run. What is the validity in that
case? In the second case, is the accuracy proportional to $\frac{1}{\sqrt{t}}$? Bob Bennett replied that the accuracy appeared to be a function of $\frac{1}{\sqrt{t}}$ the total number of samples taken, regardless of whether they were taken consecutively or on separate days. Buland wanted to know if it would not still be true that the accuracy at the higher end of the spectrum would be greater.

Favreau (Hughes) asked if Bob Buland's $n$ was the number of frequency components being analyzed; that is, the number of points being used to determine the shape of the frequency response of the system under study. Buland illustrated his reply by saying that in a noise sample $t$ long, the first frequency in the Fourier series will be $\frac{1}{t}$ followed by $\frac{2}{t}$ and $\frac{3}{t}$ etc. up to $n$, so that $n$ is the order of the highest harmonic. Ballinckrodt asked that Bob mean by the error. Bob answered that he was referring to the error between the values found from the samples available as compared with that which would be obtained from a very large number of samples. Bob Bennett said that an easy way to look at it was to think of $n$ as being a measure of the resolution, so that $\frac{1}{n}$ is essentially a measure of the bandwidth. Another way of doing it would be $\frac{n}{t}$ to use a spectrum analyzer.

Ballinckrodt remarked that accuracy is the degree to which the sample represents the actual energy. Sollenberger (Ralph H. Parsons Co.) supplied us with an equation which relates the resolution and length of the record to the accuracy.*

Buland asked about averaging separate records, to which Sollenberger replied that the formula would be modified somewhat, but that the accuracy could still be determined.

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*Mr. Sollenberger has now sent us the following references:
1. Tukey, John W. "Measuring Noise Color", Metropolitan Section, IRE, 7 November 1951. See also BTL Memorandum M4-49-110-119.

Mr. Sollenberger also writes in part: "The appendix to the Muchmore and Weiss paper is a straightforward analytical development of the accuracy to which the spectrum can be measured. The general rule to follow is given, which states -- -- that the RMS value of the noise will be correct to within sixteen percent if the bandwidth (angular frequency) times the length of the record equals 20. Curves for the accuracy of the individual spectral lines in the spectrum are also given vs. length of the record. Much of the same information is also given in the last reference."
Dick Saul (Goodyear) commented, somewhat sardonically, that for years manufacturers have striven to build a computer without noise, and now the users are going to all this trouble to put the noise back in.

McLeod told how the M.I.T.C Simulation Lab went to a great deal of time and expense to set up the best possible simulation of a complex missile system. In the absence of noise the missile hit the target every time. But with noise injected, the story was of course quite different. Does this suggest a possible short cut? Could it be that having determined the effect of noise on a system, we should forget about the system and evaluate the noise?

Norm Irvine commented that the noise spectrum would affect different systems differently depending upon the system and the frequency response of the system or any part thereof. McLeod wanted to know whether Norm was referring to small differences resulting from manufacturing tolerances. Norm replied that he thought these would probably be enough to make similar systems respond differently to the same noise spectrum. Norm said there are some types of noise which Aerofleet can handle adequately, but that he doesn't believe these are the types he has run into in actual systems. To illustrate, white Gaussian noise can be introduced into a system to get an idea of what the noise is doing to the system. However, in the actual system we don't have white Gaussian noise, because the system itself is a filter. Therefore, because the noise will affect the system depending upon the frequency response of the components, system and noise cannot be separated.

McLeod remarked that if many missiles are fired, manufacturing tolerances will become a factor in the noise. Norm told how Aerofleet ran tests some time ago to determine what tolerances are required to maintain a certain level of performance on rocket engines and found that if they attempted to introduce white Gaussian noise, manufacturing tolerances were out of the question. They then ran another analysis on the simulator, introduced the summation of 4 or 5 sine waves, and their tolerances became fairly liberal. McLeod observed that the very fact that they were able to build the rocket motor successfully showed that the second method must at least have put them in the right ball park.

Favreau called McLeod's attention to the fact that in his example of looking at the deviation of the missile from the beam he was really measuring not the noise, but response of the missile to the noise. To determine how a system responds to noise is a rather knotty statistical problem and engineering approximations must be made. If the system can be linearized quite a good analysis can be made. If it cannot be linearized, the response is not even to be normal even for normal input noise. Even there an advantage may be gained by assuming normal distribution, if the actual deviation from normal distribution is not too great. The problem is (1) To find out where the noise originates and try to describe it; and (2) To describe the system as some type of filter - linear, non-linear, or time-variant. Then with the simulator you can determine how this filter or system responds to the noise. Actually if you can measure the response of the system as McLeod said they did, you are going backwards.

McLeod asked Dow Abramis (Pomona) and Stan Rogers (San Diego) what they did about noise on their two big Convair setups. Dow replied that Pomona has several noise generators; although they haven't done as much work as the Hughes people, they have fed into the system (simulated without noise) a photoelectric type of record taken on a particular missile flight. They haven't determined whether this is
a sample, or the sample, or anything particular. Recently they have also injected random noise into a number of problems, using a magnetic tape recording of the MIT generator. Dov asked if anybody had experience in which correlation of simulation with actual results had improved when noise was taken into account. Could anyone say that because he used any particular kind of noise in his simulation he got better results?

Bennett mentioned examples in which, as in aerial machine gunnery, you rely on the noise to achieve your objective, but he wouldn't suggest designing all systems this way!

John Burke said that there are many examples in which impact error has been used to design noise filters for systems and improved accuracy has been observed. One thing that blocks the issue, however, is that most missile systems are not sufficiently reliable to allow one to distinguish between partial failures, failures, and noise. John also commented that he believes white noise is a good approximation for the majority of systems, and that manufacturing tolerances can be treated as white noise also, if you are talking about more than one test. Favreau defined manufacturing tolerances as actually system variations or variations in the filter — treat the coefficients as randomly variable from one solution to the next and the results appear just as though noise had been injected.

Jack Hallinckrodt observed that there may be a wide range of manufacturing tolerances over which a hit will be achieved every time in the absence of noise, but that the slightest amount of noise will cause some finite error.

Burke replied that this is a function of the point at which noise is injected, and Sollenberger remarked that this gets us back to the question: "How good is your simulation?"

Stan Rogers told about a rather crude experiment done at Convair-San Diego in which they ran recorded noise through a small analog computer to determine the computer constants which would minimize the effect of that particular noise on the computer output. All sorts of variations in the parameters of the computer were made until a set was found which made the computer reasonably immune to the particular noise they were interested in.

Bob Bennett commented that though it may be satisfactory in some cases, systems which are highly resonant make it very difficult to put in noise as a combination of sine waves and get out a realistic answer, particularly because in a complex system one doesn't usually know in advance where these resonances occur. Consequently even to attempt to use sine waves is risky business. And as shock and vibration people know, if you use sine waves in the testing of packaging you will miss out on some of the peak accelerations.

Bennett agreed that one of the largest problems when studying a system with noise is to get a good quantitative knowledge of the properties of the noise. Most systems, particularly those in which human beings are involved, have frequencies so low that to analyze a sample accurately can take an awfully long time. If speeding up the playback will materially reduce the observation time however, it is a very worthwhile thing to do.

McLeod then went back to the question raised by Favreau of the relationship of noise to the effect of noise. Mac had given the impression that at NALTC they were recording the response of an actual system to noise, and then were feeding
this response into the input of the simulated system. John Burke pointed out that the response of the simulated system with such an input would probably bear no relationship to the response of the actual system, because whatever noise goes into the actual system will be modified by the weighting function of the system. If it is then put into the simulated system it is remodeled so that the simulated results will be tremendously different. Bob Bulard came to Mac's rescue by explaining that the noise which they measured was the response of one part of the system, and that this noise was then injected into that part of the system which actually saw the noise.

Stan Rogers remarked that in formulating any experimental program, the statistical design of experiments should yield much more significant information for a given amount of effort. Bob Bennett replied that whereas this was undoubtedly an interesting and worthwhile technique for many things, it often turns out that with simulation the work involved in going through the design of the experiment is more time-consuming than making another thousand runs. The big advantage of simulation is that another thousand or more simulated runs don't cost much, whereas if you are going to fly missiles the design of the experiment is extremely important. McLeod said they had been through this at Mugu — whereas the design of experiments is valuable in connection with flight tests, the speed of simulation makes it unnecessary.

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After a break and discussion of possible affiliation with the Association for Computing Machinery, the talk about noise was resumed. Bob Olds (NOTS, Inyokern) asked about the proposed Goodyear noise generator, which he described as having a square wave equally distributed about the x axis with the random cross-over time determined by a radioactive source. When the square wave is put through a filter for smoothing, Olds questions just what kind of noise this actually represents. Presumably it would require a long-time constant RC filter, which would convert the wave to a series of constant slopes of varying length. If this sort of saw-tooth wave were put into a circuit with lead, or differentiating, networks, would you get your square wave back again? Burnside (North American Aviation) asked if you couldn't run that noise through another filter and get a more conventional wave form. Olds replied that you could get a higher integral of it, since each filter you put it through integrates it some more. Burnside explained that he was thinking of a special filter peaked to break up the sawtooth. Baum told us he had seen the output of one of the Goodyear generators and it didn't look like a sawtooth.

Bennett said this was because the individual steps are masked by the larger swings. Dick stated that the amplitude response is essentially Gaussian — the bandwidth they start with is in the hundred megacycle range.

Burnside said he had asked a radar system designer why he thought he could use recorded noise. The reply was that theoretically he couldn't, but to compare systems having different parameters he liked to have recorded noise which he could repeat, starting from the same point. Bob Bulard told us about using noise from actual flights in the same way at NALTC, and Dov described putting markers in the white noise tape so that a particular section can be repeated.

Bennett said he was afraid there was a catch in this technique. Suppose with one sample of noise you get a certain result in one system. With the same sample in another system you may get a result indicating that the second system is inferior.
However, if many samples of noise are put into each system the average response may indicate that the second system is actually better than the first. There is always the extreme limitation of small samples - in this case a sample of one.

Dov asked what a small sample is. In a practical case he would like to use a particular sample of noise to check his computer. Favreau suggested using a sine wave. Bennett said it was possible that something could go wrong that wouldn't show up in a particular noise sample. For instance, one amplifier may be overloading at 90 volts, and the sample chosen doesn't get up that high.

Harold Harrison, speaking of the work at Ames Laboratory, Moffett Field, told how each time the spectrum from their electronic noise generator was analyzed, it came out different. They wanted a definite spectrum, so prepared a random deck of IBM cards about 30 minutes long. They could check by setting aside a certain group of cards. One difficulty encountered was the people themselves; those used to operating the REAC weren't used to running IBM cards, and sometimes they didn't keep them straight.

McLeod suggested that we not get into the subject of human noise. Then in an attempt to recap the discussion, he asked what is the best way to evaluate a system affected by noise, in the present state of the art or lack of it.

Olds thought it might be appropriate for the Council to develop a standard noise source. Dick Baum said he believed one should always try to get a sample of the kind of noise actually present in the system. Harrison recalled his difficulties with the Ames Lab noise generator, to which Bennett replied that this trouble occurs with many noise generators. There are ways of trying to avoid it - control the environment and use a properly aged gas tube, or regulate the noise after it leaves the tube. At Hughes they use the latter method and find it quite satisfactory. They use an automatic gain control circuit which rectifies the noise and compares it with a battery reference. Noise generator variations take place only about once a day, so that the rectifier filter time constant of 1/4 of a second or so is O.K.

Bennett pointed out that in any kind of simulation the best thing is to jump in and get your feet wet - that a certain amount of living with the problem is necessary to become familiar with both the problem and the simulation technique. This is a field in which one benefits greatly from experience, and no amount of theory seems to substitute for it.*

McLeod asked whether it would mean anything if it were possible to vary empirically the noise introduced into a simulated system until its response was like that of the actual system. Would this indicate that the unknown noise in the actual system had the same characteristics as that introduced into the simulated system? Does the same kind of noise in the same kind of system result in the same kind of output?

Burke said he thought this was definitely true for linear systems, but that where he had seen it done, it is exceedingly time-consuming because of the infinite variety in the spectrum.

*Hear! Hear! There is still no substitute for good engineering judgment. No computer has it yet. Better more engineers should have it, yet!
Burnside asked if it would not be more practical to try to find some dominant frequency responsible for the type of result by use of a sine wave. Someone remarked that in simulating you would probably linearize, whereas the real system might not be linear, and therefore would act differently. McLeod pointed out that this gets us back to the inevitable question, when is your simulation valid? If you introduce noise to which the real system is not subjected you are not being realistic. Mac is searching for a way to determine the actual noise when it isn’t possible to measure it directly. It was suggested that this would be to infer the forcing function from the response.

Dannback suggested that in some cases you might be able to do a reverse simulation. Use differentiation for integration, division for multiplication, and introduce the output, already measured, into the input!

Dick Baum said that if you know where the noise enters a system and have a record of the noisy output, you can determine the input noise with a feedback circuit which he sketched on the board.

Bennett pointed out that the system would probably oscillate. Dick admitted the problem, but thought that in some cases it would work. Favreau said that using noise to determine the system was a poor approach. You would get a better idea by putting in a more definite function. For example, an impulse would give the weighting function, which essentially describes the system. Burke said he understood the question not as a desire to determine the system, but to determine the kind of noise to which the system was subjected so that you could make further tests, as McLeod suggested.

Favreau replied that if you know the system and the output noise, you should be able to determine the output noise spectrum analytically. Dow said that if the entire noise enters at the input, O.K., but if you don’t know where the noise enters, which is usually the case, then what?

Stollberger remarked that what bothers him is that the wave form associated with a certain spectrum isn’t unique. Two forms may have the same spectrum, but if put into a system they may give different results.

About then your Chairman was for the first time able to discern a pattern through all the noise! Not clearly, but garbled, distorted and almost obscured came the realization that we were raising questions faster than we could answer them. So we quickly adjourned, and within a few minutes many of us knew what we were doing for the first time since the discussion started.
The Goodyear Tire Plant

Goodyear treated us to coffee, cakes, and cokes, then a trip through the tire and rubber plant. Very interesting. Our guide knew what he was talking about, having worked at most of the jobs as part of a management training course.

We were surprised at the amount of handwork done in making a tire, especially the white sidewall ones. Such a repetitive process certainly lends itself to automation, so it must be a case of unions vs. efficiency.

The airfoam part of the plant was of particular interest. Looked as if they were baking the world's largest waffles.

Thanks for your hospitality, Goodyear!

"Equipment Reliability As Applied To Analogue Computers"

We are grateful to Stan Rogers for the following comments on the above paper, prepared by H. Jacobs Jr. for presentation at the Association for Computing Machinery General Meeting held at MIT September 9-11, 1953. We quote Stan verbatim.

Mr. Jacobs' paper on "Equipment Reliability As Applied To Analogue Computers" is a useful and well-thought-out contribution to the field of computer reliability. His paper describes a reliability program considerably more ambitious than anything we have yet put into effect. Our thinking, however, is basically very similar to his.

We are not entirely sure that periodic maintenance by substitution is the optimum procedure for our facility. We think that it may be possible to conduct the necessary tests without removing equipment from its regular position in the racks. If this can be done, it would seem to be desirable, since unnecessary handling of electronic equipment has been reported to increase the number of failures.

Although our facility is still under construction, a part of it is in operation. We are, therefore, instituting a program of checking and preventive maintenance. For the immediate future we plan to check all operational amplifiers daily or oftener for noise level, zero off-set, and for general performance. The latter test is a combination test for chopper-stabilizer gain, main-amplifier gain, and the state of the output tube. This test consists of applying a low-frequency sine wave at a gain of about 1000. In a healthy amplifier, the output must exceed a specified average value if the amplifier is to pass the test. Poor performance in the chopper stabilizer, main amplifier, or power output tube will cause the amplifier to fail this test. We plan to make this test a little more severe than any operating condition which would be found in solving a problem, so that the test will enable us to find impending failures before they occur. The tests can be carried out with a semi-automatic switch system and can be completed for the 336 operational amplifiers in less than 30 minutes, we hope. The purpose of this test is to pick out amplifiers which require service or soon will require service. It is a "go, no go" test and has little diagnostic value. Amplifiers that fail will be put through a more comprehensive bench check and repair operation to put them into much better condition than would be required to pass the general test. There is little doubt, of course, that experience will lead us to modify the above program. For an initial period, we are planning to supplement the above procedure with a systematic rotation and bench check of amplifiers such as Mr. Jacobs recommends. This will assist us in evaluating the daily check. We heartily
concur with Mr. Jacobs' remarks on the value of maintenance records and the necessity for analyzing them.

Our experience to date indicates that the greatest maintenance effort will be required on the servo amplifiers and power supplies rather than on operational amplifiers. For the servos, we are working on a fast daily check which we hope will enable us to pick out servos approaching failure before they have given serious trouble in use.

We have found, as I am sure others have, that a conventional Gm tube checker is of small value as a selector of good tubes for use in the computer. Tube performance in any particular position in an amplifier can be evaluated by plugging it into a hot spare amplifier and observing its performance on the bench.

Information Available

George Forbes has sent us copies of 4 of his Digital Differential Analyzer monographs. He states that "The purpose of this series of monographs is to enable the mathematician or engineer to most effectively utilize the equipment and personnel service of a DDA installation, and to enable the DDA technician to more fully understand the mathematical and analogue problems involved in the utilization of the machine." Your editor is not sufficiently familiar with DDA's to comment on these monographs, but will attempt to get some "expert" opinion. Copies are obtainable from the author at 10117 Bartee Avenue, Pacoima, California, at $1.00 each.

Bernard Benson says his brochures have finally caught up with their machines and has sent us one on Benson-Lehrer's Oscar (Oscillogram Analyzer and Recorder) and their Electroplotter. Anyone not on their mailing list may obtain info on Applied Cybernetics by writing them at 2340 Sautelle Boulevard, West Los Angeles 64.

Stan Rogers loaned us his excellent card file of some 60-odd references on analog computation. If readers are sufficiently interested we might get Stan's permission to make a reproducible copy.

We found "Survey of Analog Multiplication Schemes" by C. M. Edwards of Bendix Research Labs, one of the best and most interesting papers to come to our attention. We have been only moderately successful in our attempts to lick the multiplication problem, and have discussed it at Simulation Council meetings, in these pages, and with others like George Jacobi of G.E. and John Sharp of IBM, who are also interested. We could certainly have discussed the matter more intelligently if we could have seen Edwards' paper long ago.

Professor M. Z. v.Krzywoblocki of the Panel on Fluid and Solid Mechanics, University of Illinois, informs us that the information we wanted on the transformation of a partial differential system into an ordinary one with a parameter which can be handled on analog equipment will soon be published in the Bulletin of the Mathematical Society of Greece!

Pete Verhoeven sent us a clipping saying our friend "Richard V." Baum was a feature speaker at the fifth annual joint meeting of the Arizona Engineering Societies. His subject, "Analog Computing" of course. If Dick told much of what he knows, bet we could all have learned something if we could have been there!

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G. S. Marshall Co. held their annual exhibit and party at the Statler on December 2 and 3. Don't know what was in the liquid refreshments last year, but John H. McLeod III was born very soon after Suzette tried some. Invited again this year, Suzie accepted the refreshments but explained she was not properly prepared for anything more strenuous. All three of us enjoyed the party this year!

**December Meeting**

The "Second Annual" meeting of the Simulation Council will be held at the Naval Air Missile Test Center, Point Mugu, on Friday, 18th December. A business meeting in the morning will be followed by luncheon in the Officers' Club.

After lunch a visit to the Simulation Lab and the RAYDAC will be followed by a discussion of the facilities inspected.

In the Simulation Lab the following will be shown: A missile simulated in closed loop alongside the actual missile operating from the same input. The simulated and actual outputs will be recorded for comparison. A time base expander, contract- or, and shifter utilizing pulse duration ratio on magnetic tape. The three-axis flight table demonstrated in open-ended operation. A low accuracy, but simple double input arbitrary function generator and a related low accuracy curve follower.

**Subscriptions to the Newsletter**

To subscribe to the Newsletter send a check or money order payable to the Simulation Council, Post Office Box 731, Camarillo, California. The price is $6.00, to cover a one-year's subscription.

Merry Christmas

John and Suzie