Analog Computers

By JOHN BULLOCH

EDITORS NOTE:

John Bulloch is an electrical engineering senior from Fort Worth, Texas. John is a veteran and a member of Tau Beta Pi, A. I. E. E., and I. R. E. He also is a member of the I. R. E. profession group on computers and after graduation in June he will be employed by Convair as a computer engineer.

A year ago very few people at La. Tech had ever seen an electronic analog computer and even fewer were familiar with their methods of operation. Today, however, the Electrical Engineering department is running over with computer talk.

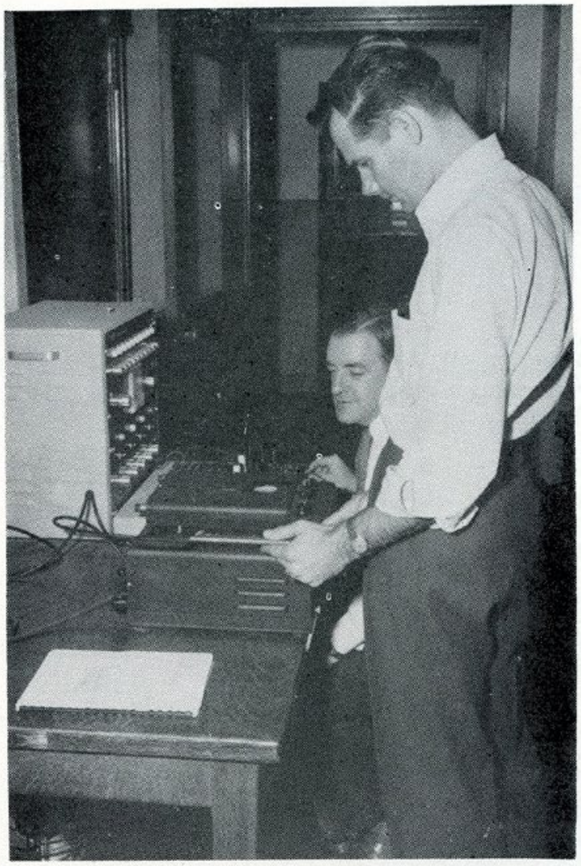
Two reasons for this new found interest are that the department now offers a course in computers and that Tech recently purchased a small electronic analog computer.

The field of electronic computation and simulation is a new and fascinating one. It is also an extremely complex field and consequently this article will attempt nothing more than a very general outline of the concepts involved.

The original concept of computation by analogy is by no means a new one. The slide rule, for instance, is a form of mechanical analog computer. A distance along the rule is analagous to the logarithm of a number. We know that if we add the logs of two numbers, we obtain the log of their product. Likewise, if we add two distances along the rule, the combined distance represents a product.

This idea of letting some easily measurable quantity represent some entirely different quantity is used extensively in computing. In particular, similarities between equations describing two entirely different systems are used. For example, it can be shown that the expression for displacement as a function of time for a diving board from which someone has jumped is quite similar to the expression for electrical charge as a function of time just after the switch is closed

The author at work "setting up" a problem on Tech's Analog computer.



Mr. Dave Johnson and Bulloch inspect the "results" plotted automatically on a roll tape recorder.

in a circuit containing resistance, inductance, and a capacitor with an initial charge. If it were necessary to study the dynamic characteristics of this diving board, it would be much easier to build its electrical counterpart and study its characteristics. Theoretically, every mechanical system has an electrical analog which are used to simulate mechanical systems.

The electronic analog which Tech now has employs further refinements of the principles mentioned. It is designed to solve equations by actually simulating mathematical operations. Voltages in the machine represent all problem variables. The machine is capable of performing addition, subtraction, multiplication or division by a consonant, and integration with respect to time. These five operations may be used to solve a great number of linear differential as well as algebraic equations.

Other more elaborate computer installations employ auxiliary equipment which is capable of multiplication or division of variables, resolution of vector quantities, and the generation of arbitrary functions. This extends the range of the computer to handle a wider variety of problems. In general, the size and complexity of the problem a computer can solve is limited only by the size of the installation.

With its proposed auxiliary equipment, Tech's computer should be able to solve as many as five

(Cont. on Page 28)

Pages 9 and 28 of Vol. 12 No. 2, March 1956

Computers —

(Cont. from Page 9)

simultaneous linear algebraic equations and possibly three linear differential equations with constant coefficients.

When the solution to an algebraic equation is reached, it appears as a voltage of definite magnitude and polarity. These answers may be determined quickly and easily by use of the vacuum tube voltmeter built into the computer. Usually, the required solutions to differential equations are not single values but rather some quantity expressed as a function of time. In this case, the computer solution would appear as a time varying voltage. If the solution could be repeated sufficiently fast, it could be shown as a trace on an oscilliscope. If the solution time is longer, a permanent graph of the solution may be obtained by use of a direct inking recorder. The time base or the solution is determined by the speed at which the paper travels through the recorder. The actual inking mechanism is a low inertia, motor-driven pen which follows changes in polarity as well as amplitude of the driving voltage. The pen can follow these changes with some degree of accuracy at frequencies exceeding sixty cycles per second.

One outstanding advantage of electronic analog computers is their ability to provide a problem solution in a wide choice of time scales. If, for example, very rapid structural vibrations in a supersonic aircraft were to be studied it would be advantageous to be able to slow down these vibrations so that a careful analysis could be made. If the system is simulated on a computer, it is usually possible to slow it down to some convenient time scale so that the nature of the vibration could be studied in detail. The limits on a choice of time scale are the frequency responses of the computing and recording elements.

Mr. David E. Johnson, Head of the E.E. Department, is now conducting a descriptive course on both digital and analog computers. The course is not designed to produce expert computer engineers, but rather to make students aware of the existance of several types of computers and the capabilities of each. Even a general background of computer techniques should prove to be a valuable asset to the graduating engineer. The design engineer of tomorrow will be as dependent on his computer as we engineering students of today are dependent on our sliderules.

THE END

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Poise — that quality which enables you to purchase a new pair of shoes without seeming to be aware of the hole in your sock.