Analog & hybrid computers in education: a panel session

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Since the analog computer is ideally suited to solving differential equations, its use in teaching that subject is well established. With the advent of inexpensive, reliable, and accurate function generators and multipliers the analog computer can also be effectively used to teach other topics in mathematics.

A number of examples are given ranging from algebra to complex variables. It is shown how the analog computer helps a student understand various concepts by giving a dynamic representation. The pedagogy is improved when the student himself changes parameters and investigates the different cases that arise. In this way he may also make some discoveries which will further strengthen his understanding.

One of the unusual examples given illustrates how the analog computer can be used to teach numerical analysis. Another shows how the teaching of linear programming can be accomplished. The great value of the analog computer in teaching various branches of mathematics to liberal arts students is stressed. Thus some of the mystery surrounding mathematics can be dispelled for these students.

by DR. ROBERT KOHR
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Analog and, more recently, hybrid computers are playing an increasingly important role in the education of mechanical engineers. This discussion contains a description of the use of analog and hybrid computers as tools in the education of mechanical engineers at Purdue, particularly in the areas of Dynamics, Instrumentation, Heat Transfer, Fluid Mechanics, and Automatic Control. A detailed description of an undergraduate course in Systems Analysis and Control Employing Analog Computers for the simulation of the dynamic response of feedback control systems will be given. Typical experiments, lecture demonstrations, and student response
to them will be discussed. The use of high speed, iterative analog and hybrid computation in graduate level courses in Mechanical Engineering will also be described.

by DR. MYRON L. CORRIN
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The use of analog computation in chemical research and the teaching of chemistry at the undergraduate and graduate levels will be discussed. In research the user must understand the capabilities and limitations of computer techniques and must be able to program his problems. Research applications in chemistry have been limited almost completely to chemical kinetics. Some such applications will be considered.

In the teaching of chemistry it is not necessary that the student understand computer operation; the instrument may be used as a "black-box" which will solve certain problems. It is necessary that the student understand graphical representation. We have employed analog computer demonstrations in courses in freshman chemistry, freshman honors chemistry and in both graduate and undergraduate physical chemistry. It has been noted that about 10 to 15% of students who participate in such demonstrations request additional training in computer use.

Demonstrations in the areas of kinetics, equilibrium, thermodynamics, quantum mechanics and surface chemistry will be discussed. Attention will also be given to the mode of presentation and to means used to induce the student to take an active role. The question of arousing teacher interest has not yet been solved.

by DR. AVRUM SOUDACK
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I would like to address myself to defining the objectives of analog computer use in undergraduate education. Much has been said about their use in engineering, vs. non-engineering. There seems to be much controversy about the level at which the computer should be introduced and the level of sophistication of the machine. The controversy goes round and round - without really pinpointing objectives.

Let me attempt to do this —

Objective 1. The use of the computer as a teaching aid.

Objective 2. The use of the computer as a problem-solving tool.

These are two widely differing objectives, each requiring a rather different viewpoint.

In a nutshell, I’d elaborate on the following:

Objective 1.
(a) The black-box approach - right down into highschool.
(b) The machine’s potential use for teaching math, physics, perhaps economics, chemistry, any subject involving dynamic changes.
(c) Computer-design for such use.
(d) Degree of elaboration in engineering courses. i.e. - our experience at U.B.C.

Objective 2.
(a) Junior and senior level. Graduate level.
(b) Degree of machine sophistication.
(c) Man-machine rapport at low cost.
(d) Optimization and design. Development of intuition.
(e) Own experience at U.B.C.

I would close with a plea to manufacturers to have these objectives in mind when developing educational machines.

by MR. A. I. KATZ
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During the past fifteen years the engineering school teacher has been confronted by the challenge to prepare the engineering school graduate to meet the technical requirements of the Mid-Twentieth Century. Those teachers who responded effectively to this demand were the most creative individuals and, as a result, established their reputation in the engineering community by virtue of the contribution they made in formulating effective engineering curricula.

The results of these efforts were a transition from “Handbook Engineering” to the use of a more scientific approach in engineering. Specifically, this has meant:

1. Greater emphasis on courses in mathematics
2. An increased role of analysis of physical systems
3. A reduction in utilization of empirical formulas
4. A reduction in detailed design effort engineering courses.

These factors have provided a strong foundation for the engineering graduate allowing him to work in many disciplines. Unfortunately, the swing of the pendulum in engineering education has tended to result in an emphasis on the preparation for graduate school, rather than in developing a student who
would enter the engineering field upon receipt of his Bachelor's Degree. In many cases, engineering educators have done little or no engineering design, nor have they had industrial experience and this has often resulted in the failure to relate the analytical techniques to the solution of engineering problems.

As we enter the latter half of the Twentieth Century, we find that engineering systems are growing more extensive and complex. There is a growing need to integrate mechanical, electrical, chemical, etc. systems into an economic and practical package. In view of this trend, the engineering educator must provide the engineering graduate with a better realization and understanding of the "systems approach" to engineering.

The most effective means for developing a "systems approach" is the technique of simulation. (The role of simulation in the Aerospace field is an excellent example of an integrated approach to solving complex problems.)

The key element in engineering simulation is an analog or hybrid computer which has a one-to-one relation to the physical system being modeled. These computers inherently provide the OARS in approach which is the keystone of simulation:

- OBSERVE
- ABSORB
- REACT
- SEARCH

The success of systems analysis in large and complex organizations hinges upon the speed of communication between man and machine in a simulation, since simulation is a learning and experimenting process. The ease of making structural changes in a simulation, relating simulation elements to physical system elements and the convenience of interpreting the output of a simulator are essential for effective systems analysis.

The engineering educator needs to utilize analog and hybrid computers to bring to the engineering student the concepts of systems engineering. In addition, he must provide an understanding of these tools, so that the engineering graduate may utilize these computers to their best advantage in solving modern engineering problems after graduation.