Meetings

Biomathematics and Computer Science

The fifth annual symposium on Biomathematics and Computer Science in the Life Sciences was held in Houston, Texas, on 30 March–1 April 1967. Approximately 300 persons attended. Subjects included: experimental data analysis, mathematical models of physiological processes, techniques for laboratory automation, medical information management systems, computer-aided instruction, retrieval of heart-disease literature, patient monitoring and process control, and computer image-processing for chromosome studies.

William Bossert (Computation Laboratory of Harvard University) described the on-line use of computers in the biology classroom. He pointed out how models of very complex biological systems are being developed for direct observation of the behavior of dynamical systems. The models permit selective removal of complexities in the system that are not relevant to the study. His examples were in the study of problems in renal physiology and population biology. He obviously was convinced that substitution of a simulation for the natural system increases the creative role of students by making it easy and inexpensive for them to modify a plan of investigation to suit their own needs.

A specific medical inquiry system designed to provide even remote users with immediate access to both computer-stored and current medical literature on coronary heart disease was described by Douglas Talbott and Ken Brown (Cox Coronary Heart Institute). The primary data base for the system consists of abstracts of coronary-heart-disease literature published in this decade. Abstracts are prepared by authorities in the medical subject fields and reviewed by others before incorporation into the data base. Abstract quality is constantly spot-checked, and instant retrieval of the original article is possible by use of photochromic microimage cards. Abstracts prepared quarterly for computer tape are 400 words long and currently cover 110 periodicals generating about 200 abstracts per month. Key words are computer-extracted from title and body of the abstract. The results of this prototype system justify further development and implementation of other specific-inquiry programs.

An effective automated clinical laboratory data system, described by Irwin Etter and Hugh Jones (Mason Clinic), can automatically serve many analytical instruments normally found in hospital laboratories. This system produces a laboratory report suitable for the hospital information system. For slow instruments (that is, amino-acid analyzer) off-line operation is preferred. Typical processing time for an 18-hour amino-acid analysis was 4 minutes of off-line computer-system time. The system detects signal peaks and determines the value of concentration based on previously performed calibration runs. For automated continuous-flow instruments, peaks are verified by time of occurrence. The number of peaks is matched with the number of specimens being processed and is checked against other limitations before being accepted as valid peaks and positively identified with the processed specimen. Drift corrections, determined by processing pool samples interspersed among unknowns, are programmed to correct the previously determined concentrations of the unknowns. About half of a technician's time is spent with functions that could be done more efficiently with a machine system.

Arnold Kadish described a continuous monitoring and control system developed at Cedars–Sinai Medical Center, Los Angeles, for improved regulation of blood-sugar levels. Adequate diabetic regulation demands a closely regulated diet and insulin relationship; most patients have wide swings in their regulation. Avoiding neuropathy, retinitis, and atherosclerosis requires close stabilization of blood-sugar levels. To quantitatively measure use of glucose in terms of insulin dosage, glucose is monitored continuously. The patient, deprived of nourishment, receives a test dose of crystalline zinc insulin; glucose is infused continuously at the rate required to keep the ratio of concentrations of blood to glucose constant. The experiment continues until blood sugar rises in the absence of infusion (within 2 hours). This procedure is repeated on the same subject to confirm the reproducibility of the glucose-delivery schedule; the procedure is repeated after a test meal. The difference in the required glucose delivered with fasting and test-meal experiments is determined from the recorded blood and glucose curves reported on the digital computer readout. The computer simulation can predict the effect upon blood sugar of any combination of dietary carbohydrate, fat, and protein during different times of the day, without necessarily rerunning the experiment. Timing and composition of feeding and dosage of crystalline zinc insulin can be determined specifically for each patient. This method can provide useful data concerning the patient's responses to varying circumstances of exercise, infection, and emotional factors.

Thomas Lynn and William Harless (University of Oklahoma Medical Center) have experimented with computer-assisted instruction in graduate education. About 200 hours of instruction time are required for the development of one hour of effective student instruction by computer. This has been achieved with the use of a Coursewriter language by which the instructor corrects and edits the text. In 1966, a total of twelve computer-aided instruction lessons were developed. Student reactions were mixed. The overall experience was favorable. The knowledge that some material would be specifically covered in each computer-aided instruction lesson allowed more freedom in the lecture portion of the course. The cost per unit of instruction will drop considerably as instructor and programmer time can be utilized more effectively.

John McLeod (editor of *Simulation*) has followed development of simulation techniques in numerous fields of application. He advocates development of a set of compatible "core simulations" of physiological systems. The

system must be "loose-leaf" and maintained through a continual process of growth and refinement. The PHYSBE (PHYsiological Simulation Benchmark Experiment) simulations will be designed to embody eventually the best of current knowledge concerning both the simuland, the system being simulated, and the techniques of simulation. Documented and debugged, these proven simulations would give the investigator an advanced staging area from which to proceed with further experiments, thus helping to avoid "reinventing the wheel" and other overlapping effort.

These standardized simulations also offer a means of comparatively evaluating simulation equipment and techniques, thus making it possible to make selections more objectively. Other applications include driving the model by selected independent variables, which are easy-to-measure functions, in order to compute difficult-to-measure variables that can be recorded from the model. This method is similar to the one used in the application described by Kadish for the determination of insulin requirements. To date, it seems that most biological simulations have required in the order of 50 to 100 operational amplifiers, and that while many of these systems are interconnected (for example, respiratory, cardiovascular, renal, and nervous systems), specialists have been most interested in one organ system at a time. The PHYSBE concept allows simulation of such systems more realistically by "closing the loop" around them. Thus the more important feedback and cross-coupling effects can be provided.

Baker Mitchell demonstrated the use of the PHYSBE concept at The University of Texas M. D. Anderson Hospital and Tumor Institute. He added inertial and gravitational terms, atrial pumping, arterial wall viscosity, and variable heart rate to the basic simulation, and implemented a detailed description of the left atrium, left heart, and a three-section aorta for study on the analog portion of the hybrid simulation. He emphasized the necessity for deriving the details of such a model from physiologic considerations.

Robert Linebarger (NASA Ames Research Center) implemented PHYSBE using the DSL/90 digital simulation language and a remote terminal connected to a computation center over a standard telephone line. The program used the time-shared computer conversationally. George Burgin (Decision Science) discussed a straightforward FORTRAN implementation of PHYSBE, and the suitability of high-level, digital computer simulation languages for simulation of physiological systems.

Mary Evans and Jim Sweeney (Tulane University) described an approach to the recognition of chromosomes from photomicrographic image processing. The centromere is used as a reference point for measurement of branch lengths and widths for preliminary sorting in accordance with the Denver classifications of chromosomes.

Louis Lauler and Dale Fuller (Lockheed Missiles and Space Company) presented a clinically oriented hospital information system with many terminals. The system is used to retrieve and select message elements from a structured information hierarchy displayed on screens and called or manipulated with light pens. The system starts with identifying the physician to the machine, which gives a list of his current patients. Using the video matrix terminal he adds or deletes information about any of these patients. A specific application is the selection and modification of medications. There are about 10,000 choices of different medical order entries covering drug orders, general care, diet, laboratory, x-ray, and other choices. A final descriptor can be reached quickly within three or four inquiries.

Tate Minckler and Caroline Horton (University of Texas M. D. Anderson Hospital and Tumor Institute) discussed user control of a Medical Information Management System (MIMS). Current developments were demonstrated at The University of Texas Graduate School of Biomedical Sciences with an IBM 1050 terminal typewriting system and an SDS-930 computer. The system is used for the management of research files as a prototype for hospital information management. The concepts lead to the need for centralized files with many access terminals in which patient information retrieval is based on a *Who, What, When* approach under the user's control for definition, collection, transcription, and editing of data which is of variable field lengths, and used in a generalized hierarchical filing system which is independent of the user's format and therefore allows additional freedom for the user to structure his files as he wishes.

Robert Schwarzbach (University of Pittsburgh Medical Center) reported on conversational computer language for use on a time-sharing system. Simplicity of language and conversational mode of operation of the system offer advantages to medical research personnel in allowing rapid analysis of data soon after experiments are completed. Analyses which formerly required several hours are now done within minutes.

New precision techniques for multicompartment analysis of biochemical systems provide estimates and weights for solving nonlinear tracer problems of carbohydrate and lipid metabolism, according to Abraham Silvers (Stanford University School of Medicine). The investigator can use sums of exponentials to get initial estimates and weights which previously required prior knowledge of these quantities.

Donald Wright described a patient-monitoring program for patients undergoing cardiac surgery at the University of Virginia Medical Center. He used a hybrid computer for processing the electrocardiogram, multiple arterial pressures, venous pressures, air-wave pressures and flows, and multiple temperatures. The Center is developing new techniques for continuous measurement of multiple biochemical parameters consisting of arterial *p*H, arterial PO_2, arterial PCO_2, and serum electrolytes. Current research is aimed at providing precision processing and increasing ability to reject erroneous data.

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Calendar of Events

National Meetings

June

15–16. American **Rheumatism** Assoc., New York, N.Y. (Miss M. Walsh, The Association, 1212 Avenue of the Americas, New York)

15–16. **Soil, Water and Suburbia**, Dept. of Agriculture and Dept. of Housing and Urban Development, Washington, D.C. (S. Kasper, Room 1201, Dept. of Housing and Urban Development, 1430 K St., NW, Washington, D.C.)

15–17. American Assoc. of **Physics Teachers**, summer mtg., Canton, N.Y. (A. B. Arons, Physics Dept., Amherst College, Amherst, Mass.)

15–17. Symposium on **High Energy Radiation Therapy Dosimetry**, American Assoc. of Physicists in Medicine, New York, N.Y. (L. H. Lanzl, Dept. of Radi-