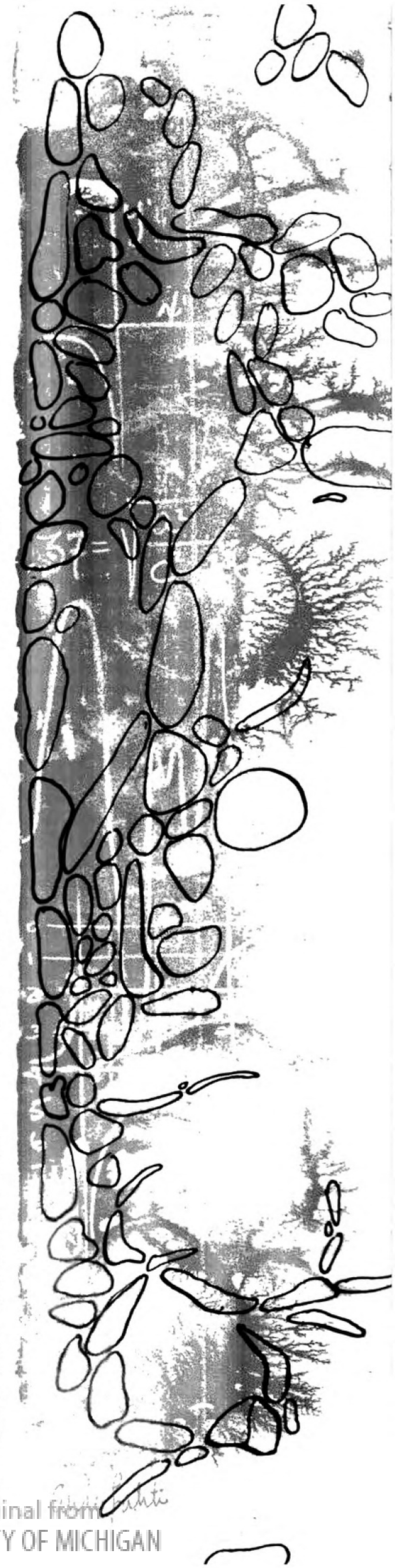
BIO



The various fields of engineering have advanced by leaps and bounds. Meanwhile, medicine and the biological sciences have also rapidly progressed. With the advent of bio-chemistry and, more recently, bio-physics, the possibilities of a new field, bio-engineering, became increasingly evident. Today bio-engineering is growing by leaps and bounds.

In his perpetual effort to improve his environment and his general lot in life, man has been naturally inclined to study and develop the many branches of the physical and biological sciences. When man discovers an untraveled route in science or finds a problem that he cannot solve, he integrates the principles of the sciences more familiar to him and creates a new science. For centuries man has explored the physical and biological sciences separately, but only in recent years has he attempted to integrate these two main branches of science. The product of this cross fertilization has resulted in the discipline called bio-engineering.

What are the problems that caused this new field of engineering to evolve? The Chemical, Mechanical, and Aeronautical engineers, understand and are able to solve problems involving chemical processes, heat transfer, energy release, fluid flow, and their controls in engineering systems. How can he apply his knowledge to the many physiological systems that involve the same processes? To answer this question, the engineer must have a working knowledge of the biological sciences in addition to his knowledge of the physical sciences.

The Electrical and Instrumentation engineers are acquainted with the theories of circuitry, computers, and the measurement of non-linear system behavior that is also exhibited by the biological system. The need for physiological data requires the best instrumentation the technology of electronics can conceive, and is constantly increasing. The Electrical and Instrumentation engineers can obviously do much for the biological sciences.

The Materials engineer is concerned with inanimate materials. How can he use his knowledge in the materials of the biological systems?

The Industrial engineer knows how to design and develop more efficient and more practical operations. How can he apply his knowledge to the biological sciences?

Questions such as these caused the creation of the field of bio-engineering, a cross breed of the physical and biological sciences. The ultimate goal of the bio-engineer is to discover, understand, and apply the general laws involving [both living and inanimate systems] (for the benefit of mankind).

Bio-Engineering at the University

Here at the University of Michigan, the Bio-Engineering Program began in 1952 when the University began training students as combination specialists in bacteriology, bio-chemistry, and chemical engineering. This course of study was confined to the graduate level for several years and by 1961 approximately five Ph.D.'s were graduated from the program. Within the past year the original narrow concept has expanded greatly to include not only students from the Engineering College, but students from other colleges in the University as well.

Bio-Engineering was offered as a program leading to a degree in the

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by Karl Legatski

expanded context for the first time during the fall semester of 1962. Undergraduate students entering this program are expected to take the prerequisites to the advanced biological and medical sciences, such as biology, bacteriology, organic and physical chemistry, and comparative biology, in addition to their regular engineering courses. The faculty plans to allow the students to plan their own course of study as they advance in the program. Because of this, the areas of study that will lead to a degree in Bio-Engineering have been greatly diversified. The goal of the graduate students will be to conduct research on biological and physical systems from an engineering point of view.

Several research projects in this field are being conducted or have been conducted at the University of Michigan as well as elsewhere. In one study it was learned that gamma rays could be used to lengthen the refrigerated life of fresh foods. Preliminary studies showed that dosages of radiation large enough to sterilize the food products tended to give undesirable odors and flavors to the food. However, it was found that doses equal to 1 or 2 per cent of the sterilizing dosage destroyed 90 to 99+ per cent of the bacteria in the food without producing undesirable changes. Items such as hamburger that would normally begin to spoil within a few days could be made to last a week before the bacterial population becomes excessive.

Another project involved the use of gamma rays to sterilize meat that had been inoculated with spores. Ground beef was inoculated with various dosages of *Clostridium botulinum* spores and subjected to radiation. The meat was then incubated and tested for culture growths. The samples that had had sufficient dosages of radiation were sterile. Radiation was also used to sterilize bone transplants and pasteurize whole eviscerated chickens. Complementary effects of heat and radiation on food microorganisms have been investigated, too.

In the Mechanical Engineering Department studies in prosthetics and orthodics have been conducted. Since World War II interest has increased in this area because of the great number of people that were crippled during the war. Various methods of bracing crippled limbs were studied in an effort to find the way that would give the patient the most freedom of movement.

The Industrial Engineering Department has a number of projects at the University Hospital. Surgical supply costing, central service inventory, and catheterization sets are being studied in an effort to cut cost and increase efficiency and practicality. A study is being made to find the best ways to stock and distribute pharmaceutical products. Other projects involve material control, patient transportation, and patient census.

In another project the basic differential equations relating the pressure, momentum, and position of the blood in the arteries with respect to time were derived. With the aid of computers, engineers can use these equations to locate possible obstructions or weak points in the cardiovascular system by comparing the velocity, pressure, and flow rates in the arteries.

Bio-Engineering Projects

A great number of studies are being conducted at other universities, various industrially sponsored research centers, and in some branches of the armed forces. For example in Tubingen, Germany, four scientists devoted several years to a seemingly trivial study of the responses of a beetle to moving light patterns. From this study they were able to design some radically new ground-speed indicators for airplanes.

At the U. S. Air Force Cambridge Laboratories a study of the anatomy of human speech was conducted. A procedure was devised to detect malignant growths in the larynx. In this procedure the patient would have his voice recorded, while he was reading standard phrases. The speech waveform could then be studied and compared with characteristic patterns to detect the existence of growths.

Hig-speed equipment is required for the accurate measurement and analysis of the mechanical events in active muscle. Engineers developed instruments that can provide information to specify completely both transient and steady-state mechanical properties of muscle. A hydraulic servo-valve, controlled by analog units, can be used to control the speed of shortening of muscle at rates as high as one millimeter per millisecond. Force on the muscle can be measured by a strain gauge with high natural frequency and low compliance. An error indicator is fed a signal proportional to the measured force and in turn controls the servovalve piston. Constant forces can be maintained in this manner.

Realizing that anesthetics and the exposure of the heart affect cardiac function, engineers have devised ways of gathering information about the function and control of the heart

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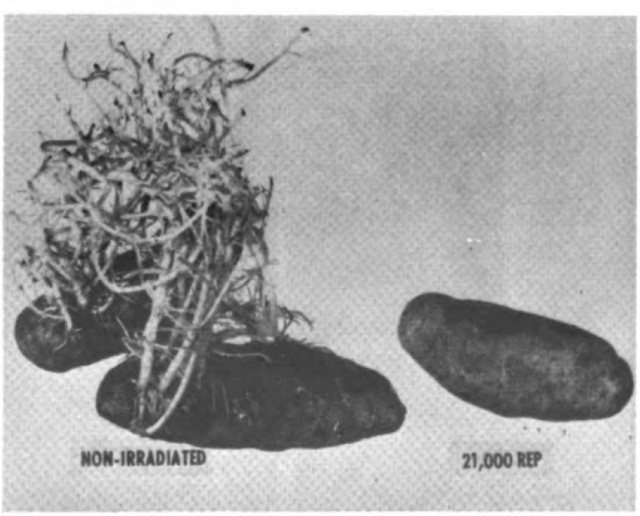
from intact conscious animals. The dimensions of the heart chamber are obtained by measuring the transit line of pulsed sound passing across the chamber. Blood flow can be measured by comparing the upstream and downstream transit lines of bursts of sound passing through moving blood. A miniature, differential transformer type of pressure transducer was developed for measuring pressure within a heart chamber. Thanks to these instruments, hypotheses regarding cardiovascular function and control may be rapidly and accurately evaluated.

Prof. Juvinall (second from left) demonstrates a pneumatically powered arm brace. The five joints in the brace have the same axes as the anatomical axes.

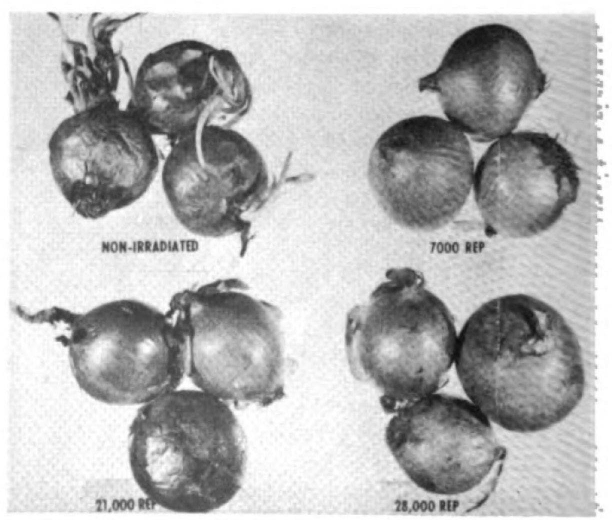
The Future of the Bio-Engineer

It can easily be seen from the wide number of projects' being conducted by Bio-Engineers that there are numerous paths of study available to the student who enjoys applied research in the physical and biological sciences. Employment opportunities are available for Bio-Engineers at all levels of accomplishment. Government positions are open to those who are interested in research and have advanced degrees. Due to the rapid influx of students interested in the bio-engineering field, graduates interested in teaching and research are also in demand. Industry sorely needs Bio-Electrical engineers that can develop, produce, and maintain sophisticated medical electronic equipment; Industrial engineers who can utilize operations research to increase efficiency in hospitals and various food and drug industries; and Bio-Chemical engineers who have a working knowledge of biochemistry microbiology, computer technology, biophysics, and molecular biology.

Medical researchers have found ways to save thousands of lives, and engineers have discovered numerous devices that simplify our everyday life. Yet science has no pump as good as the human heart, no camera as good as the human eye, and no computer as good as the human brain. Can man duplicate these God-given instruments? What are the relationships between these marvelous living systems and the inanimate systems that the engineer already builds and professes to understand? Among the men who answer these questions for the future will be the Bio-Engineers.



This photograph shows a comparison of a non-irradiated and irradiated potato after 3 months. There was little change in taste of the irradiated potato.



The onions shown were irradiated three months before the picture was taken.