

A PERSPECTIVE

COLLABORATIVE BIOMEDICAL RESEARCH: PAST, PRESENT, AND FUTURE

by Richard J. Johns

The Applied Physics Laboratory has made important contributions to the solution of problems in biology and medicine. This issue of the *Johns Hopkins APL Technical Digest* describes a spectrum of the Laboratory's activities in biomedical research. These activities address a broad

range of biomedical problems, from impaired hearing and vision to the mechanism of pain. The articles in this issue also reflect many areas of engineering science and technology, including signal analysis, microfabrication, optics, and circuit design.

The success of The Johns Hopkins University Applied Physics Laboratory—Medical School Collaborative Biomedical Program suggests two questions: First, how did the program arise? Second, is there any rational basis for predicting its direction in the future? The program began in 1965 with the belief that the technological talents of APL could be used to solve problems in biology and medicine. That view was presented to the Advisory Board of The Johns Hopkins University Medical Faculty by a committee—chaired by Vernon B. Mountcastle, Director of the Department of Physiology—that included A. McGehee Harvey, Director of the Department of Medicine, and Russell H. Morgan, Director of the Department of Radiology, as its other members. The committee was charged with formulating recommendations for the Medical School in the emerging discipline of biomedical engineering. They recommended that biomedical engineering be established as a department (initially as a subdepartment), and that one of the department's charges be to explore ways to bring APL's expertise to bear on problems in the clinical and basic science departments of the Medical School and Hospital.

The Biomedical Engineering Department was established at the Medical School in 1965. The prospect of a

DEDICATION

This issue is dedicated to the community of scientists and engineers across the greater Hopkins campus who have advanced biomedical research through The Johns Hopkins University APL—Medical School Collaborative Biomedical Program. Past successes and present strengths highlighted in this issue hold the promise of renewal and future excellence.

—David G. Grant, Guest Editor

collaborative research and development program attracted the immediate and enthusiastic support of Ralph E. Gibson, Director of APL. A man of action, he promptly enlisted the efforts of Frank T. McClure, Chairman of the Research Center, and Joe T. Massey of the Principal Profession-

al Staff in the Research Center to work with me in translating the concept into reality.

We were fortunate that this new endeavor saw early successes, which had three principal ingredients:

1. The projects sought technological solutions to significant biomedical problems. Our projects were not new technologies in search of a problem.

2. Investigators from both the Medical School and APL were personally committed to solving the problems. Their commitment, together with bilateral professional competence, served to avert the interpersonal and communicational difficulties that often afflict cross-disciplinary working relationships.

3. The initial target area, ophthalmology, offered an abundance of potential projects, the steadfast support of A. Edward Maumenee, Director of the Wilmer Institute, and the understanding and support of Mathilda Soloway of the National Institute of Neurological Diseases and Blindness.

The first ensemble of collaborative research projects was funded by the National Institutes of Health as a research program grant. This same program grant is still funded some twenty-six years later, owing to a steady succession of meritorious new research projects. The research described in five of the articles in this issue was supported by this grant.

This issue of the *Digest* provides a good illustration of present activities. What of the future? Is it possible to anticipate the direction of this kind of collaborative effort?

The answer is yes and no. Although we may rationally extrapolate from emerging biomedical problems and emerging engineering technologies, we must acknowledge that unexpected developments may arise. Therefore, the future vigor of this interdisciplinary collaboration requires that we extrapolate from current trends and that we also be prepared to seize unanticipated opportunities. A few examples can illustrate what otherwise would be platitudinous observations.

Emerging problems in biological research are at the reductionist and the integrative extremes. At the reductionist level, emerging issues involve understanding the relationships between macromolecular structure and function: What are the operating details of DNA transcription machinery? What are the structural changes associated with the opening of a voltage-sensitive ion channel in the cell membrane? New, potential problem-solving technologies for such problems include imaging methods at the atomic, molecular, and subcellular levels (e.g., atomic force, conductance, and nuclear magnetic resonance microscopy). Microsensors and microactuators will also find applicability.

Problems at the integrative level of biology include understanding brain function and the interactions between multiple, nonlinear, and adaptive physiological control systems. Here, computers with massive parallel processing can be used to test hypotheses about how complex neural systems operate. Microfabricated sensors and stimulators can provide needed input data. Similar approaches can be used to acquire data and to model complex biological control systems. The major benefit of quantitative models is their use in suggesting experimentally testable hypotheses.

In the clinical area, noninvasive diagnostic imaging (magnetic resonance imaging), minimally invasive diagnostic (laparoscopy) and therapeutic (catheter angioplasty) procedures, and critical care monitoring are significant problems. Here, many technologies can contribute to solutions.

In our medical care system, the overwhelming concerns of cost of care and access to care are, in part, related; the cost of care is one of the major barriers to access to care. We often blame new technology for escalating costs but ignore compensatory cost savings. For example, when a diagnosis is made by magnetic resonance imaging that would otherwise require exploratory surgery, the cost of the latter is not deducted.

Can technology be used to reduce costs? I believe that clinical information systems and straightforward expert systems can reduce the waste of diagnostic and therapeutic resources. Such waste (and cost) control improves the quality of care. An expert system can encourage the optimal diagnostic and therapeutic strategy. Computer technology and the man-machine interface have made steady

advances. The difficulty is not with the technology but with its acceptance by corporate and individual health care providers. For example, the Oncology Clinical Information System developed in collaboration between APL and the Oncology Center in the 1970s remains the most advanced system in use at Hopkins today. User acceptance is changing rapidly with the current generation of computer-facile physicians.

Finally, we must be prepared to exploit unanticipated opportunities, and that will require broad-based tracking of emerging technologies and biomedical research that is at the cutting edge. An advantage to us at Hopkins is that the various missions of APL prompt the professional staff at the Laboratory to keep abreast of these developments. By exposing biomedical problems to such expertise, Hopkins can continue to discover innovative solutions to important problems.

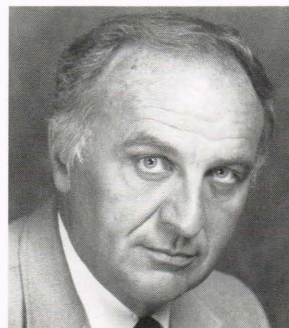
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GUEST EDITOR



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