VaNTH ERC in Bioengineering Educational Technologies

Vanderbilt University (lead institution)

Uniting educators and engineers, in industry and academia, to develop the curricula and technologies that will educate future generations of bioengineers

A National Science Foundation Engineering Research Center since 1999

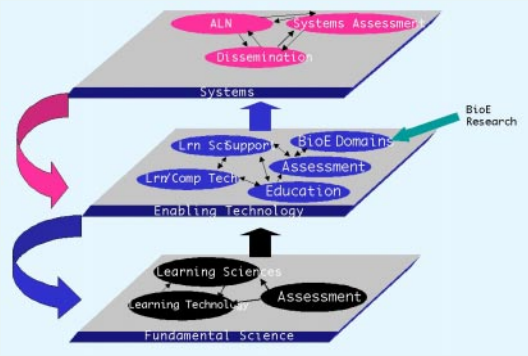
Partner Institutions:

- *Harvard/MIT Division of Health Sciences and Technology*
- *Northwestern University*
- *University of Texas-Austin*

This project aims at developing the educational resources to prepare for the future of bioengineering. Some features of that future are discernible today. The merging of physics, mathematics, and engineering science with biology will lay the foundation for breakthroughs in basic understanding of the living state. Advances in the basic principles and practical implementation of devices, materials, and instruments to noninvasively diagnose and treat with minimum disruption and maximum effectiveness a wide range of human diseases will occupy many bioengineers. The utilization of bioengineering concepts in the design of biomimetic materials and processes will have significant effects on a number of fields beyond the health sciences. The future of bioengineering appears to be bright with promise. However, extrapolation of the present educational paradigm will not fulfill this promise. To attract and retain talented and energetic learners, bioengineering needs a much larger body of integrated, time-tested educational materials. While the scientific and engineering literature of bioengineering is vast, tested teaching materials are scarce. A cogent body of bioengineering knowledge and proven methods for helping students with diverse characteristics acquire that knowledge in many contexts is the foundation on which the desired future can be built. VaNTH is pursuing research, technology and systems development aimed at providing concepts and methods for bioengineering education broadly defined.

Research

A fundamental goal of VaNTH is to integrate learning science, learning technologies, and the domains of bioengineering. At the fundamental science level, we are pursuing basic research thrusts in learning sciences, in learning technologies, and in the development of assessment methods for the teaching of bioengineering. In the learning sciences area, we have a major project studying learning and learners in bioengineering. We propose to develop a better understanding of bioengineering students as learners and the methods that help them learn. We need to do this in order to determine what the impact of technology and curriculum change might be and to optimize our teaching in all domain areas of bioengineering. Transferring curriculum and deliverables to other institutions will also require this knowledge. We are also pursuing a project aimed at middle school students with the goal of identifying bioengineering examples that could help anchor instruction for the teaching of basic scientific principles at the middle school and secondary levels. In addition, we are seeking to understand how to construct teaching materials in bioengineering that will be learner centered, knowledge centered and assessment centered. This work will seek to examine a number of challenges in learning



The VaNTH ERC's strategic plan

science that bioengineering education offers. These include a determination of the range of knowledge needed to understand bioengineering, principles of domain module design, methods for the effective incorporation of technology into the learning experience and the development of assessment methods for the effectiveness of new learning materials. We consider assessment to be a major area of research emphasis. In the area of learning technology, we plan to conduct research to invent and extend learning technologies for bioengineering education and to implement and evaluate those technologies in the bioengineering classrooms and distributed venues of the VaNTH ERC. These efforts will include examinations of web-based learning in asynchronous (ALN-Asynchronous Learning Networks) and synchronous forms and the development of new technologies to support the aims of the learning science and domain projects.

At the enabling technology level, we are examining the structure of knowledge in the major domains of bioengineering. These domains include the following: role of biology in bioengineering, quantitative/systems physiology, tissue and materials engineering, biotransport, bio-optics, design, biotechnology, biomechanics, bioenergetics and thermodynamics, bioinstrumentation, bioimaging, biosignal analysis, and roles of bioengineering in other fields of engineering. In all cases we seek through our education research thrust a thorough analysis of the structure of knowledge in these fields, with attention to the development of modular teaching materials that could be used in part or in aggregate to form parts of courses or whole courses. Learning science, learning technology, and assessment will be integrated into these modules.

Finally, we plan to disseminate these materials to undergraduate and graduate programs in bioengineering, to middle and high schools, and to the industrial

and practitioner communities through continuing education programs.

Education

The entire goal of the VaNTH ERC is education. However, there are special programs aimed at involving undergraduate and graduate students in the work of the ERC. Undergraduate students participate as research assistants on ERC projects and act as testers and advisors on the effectiveness of new learning materials. Graduate students in learning science and computer engineering/science will use ERC projects as thesis and dissertation projects. Graduate students in bioengineering at the 4 campuses undergo special training in learning science and technology and act as research assistants for the development of domain projects. Industrial and practice partners participate through advice on knowledge and skills needed by students entering their workforce and review of continuing education modules.

Industrial Collaboration/Technology Transfer
The VaNTH ERC seeks industrial and practitioner partners (IPPs) who are interested in the development of bioengineering education. The ERC offers 5 levels of membership depending on the level of interest of the IPP. Major partners participate in research, instructional module development, governance, and advisory boards of the ERC and receive access to university facilities, continuing education courses, and students for internships and other activities. Members range from large biomedical device or pharmaceutical firms to smaller biotechnology companies and include organizations interested in electronic publishing. Members may make special arrangements for the licensing and publishing of VaNTH materials and other intellectual property stemming from the center's work.

Facilities

Since the focus of our center is education, virtually the entire complement of facilities in bioengineering at the VaNTH institutions can act as resources for the conduct of ERC efforts. At Vanderbilt, the centerpiece for biomedical engineering research and education is 16,000 nsf of newly refurbished instructional, laboratory, and office space that was provided to the Department of Biomedical Engineering in summer 1997. This facility includes 1800 nsf of laboratory instructional space for undergraduates. Approximately 800 nsf is dedicated to the headquarters of the VaNTH ERC. In addition, 5 major laboratory complexes are located here for biomedical engineering research. Specialized learning technology facilities are available for the production of multimedia educational systems in Vanderbilt's Peabody College Learning Technology Center. At Northwestern, the Biomedical Engineering Department occupies 16,000 nsf. Approximately 1700 nsf are dedicated to BME instructional purposes. Fully equipped research laboratories for biomedical engineering research also occupy this space. At the University of Texas-Austin, research facilities in biomedical engineering include 10 laboratories for graduate student research. In addition, a major computerized instructional facility is maintained in the Department of Electrical Engineering and Computer Science and is available for biomedical engineering education. The Health Sciences and Technology Program is housed on the Whitaker School of Biomedical Sciences at MIT. Students in this program have access to an exceptionally broad array of research and instructional facilities at both MIT and Harvard.

Center Organization and Leadership

The lead institution for the VaNTH ERC is Vanderbilt University. The director resides at Vanderbilt and reports to a committee of the Dean of Engineering and the Dean of Peabody College (Vanderbilt's school of education). The director and the co-directors at each institution in VaNTH form an executive committee for the administration of the program. The major thrusts of learning science, learning technology, assessment, education, bioengineering domain projects, and dissemination have thrust leaders who coordinate the activities of each effort.

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