". . . the potential to make man bionic."

Biomedical Engineering in Connecticut

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"We can rebuild him. We can make him better, stronger, faster. . . ." For people over 30, these words may evoke memories of 1970s television's *Six Million Dollar Man*. However, for people working in today's biomedical engineering (BME) disciplines it might be considered a mantra.

What is BME?

One of the youngest and fastest-growing engineering fields, (particularly among women,) BME combines engineering design expertise with medical or biological science. Enter the words "biomedical engineering" in an Internet search engine and more than a million entries appear.

The Tufts University website (http://ase.tufts.edu/biomedical/about/discipline.asp) lists a number of specialties within BME including:

- **biotechnology**
- creating or modifying material for beneficial ends, including tissue engineering
- **physiologic modeling, simulation and control**
- using mathematical and physical modeling and computer simulation to understand physiologic relationships
- **biologic effects of electromagnetic fields**
- studying the effects of electromagnetic fields on biologic tissue
- **biomechanics**
- studying static and fluid mechanics associated with physiologic systems
- **biosystems**
- integrating biology, bioinformatics, complex systems analysis, in silico biology (use of computers to simulate or analyze a biological experiment)
- **biomedical instrumentation**
- developing biosensors to detect, monitor and measure physiologic events
- **medical imaging**
- providing graphic displays of anatomic details and physiologic function
- **prosthetic devices and artificialorgans**
- designing and developing devices for therapeutic replacement or augmentation of bodily function
- **rehabilitation engineering**
- designing and developing therapeutic rehabilitation devices and procedures
- **ergonomics**
- applying scientific knowledge to the design of devices, objects and environment for human use
- **medical informatics**
- analyzing patient data, interpreting results and assisting in clinical decision making, including expert systems and neural networks
- **clinical engineering**
- designing and developing clinically related facilities, devices, systems and procedures
- **bioengineering**

applying biology, engineering and clinical sciences skills to the fields of life science and health care delivery

Why is BME important?

According to Dr. Neil Yeston, vice president of academic affairs at Hartford Hospital, BME offers tremendous potential for improving quality of life. Yeston identified three areas he calls "the greatest examples of the promise BME holds for the future": robotics, imaging technology and genomics.

Yeston predicts that the most promising application of robotics technology will be its role in precise, minimally invasive and more efficient surgery. Robotic systems like Hartford Hospital's daVinci Surgical System® allow all instrumentation within the patient to be placed remotely, provide surgeons with magnified views that are more precise than those available using current surgical binocular loops, and eliminate even the slightest tremor in a surgeon's hand. "This technology is currently being used for procedures like kidney and prostate removal," Yeston said. "It offers tremendous possibilities in micro surgery (i.e. nerve and cardiac surgery) and it will likely make possible advances in surgery within cavities and structures that are difficult to see with the human eye."

New imaging technology is replacing invasive diagnostic procedures with safer, more rapid techniques. "When CAT scans emerged in the 1970s, a typical abdominal diagnostic test took 45 minutes," Yeston said. "Today, a similar procedure takes only seconds and provides better imaging and new capabilities. The new technology requires less radiation and supplants the risks and pain of some of today's diagnostic procedures."

And, Yeston looks to another exciting future application of BME: genomics. "While the media has focused on genomics as a tool to clone an ideal individual or modify genes, for me, its most promising application is in providing ideal preventive therapy," Yeston said.

Hartford Hospital is partnering with Hartford-based Genomas, Inc., founded by Academy member Gualberto Ruaño, to develop technologies that offer the potential to individualize the prescription of medicine. "Consider what these technologies could do for patients who need high cholesterol medicine as just one example," Yeston said. "One patient might require four times as much as another patient because each person's genetic make up is different. Emerging technologies will allow doctors to immediately prescribe the exact amount of medicine each patient requires."

BME also holds tremendous potential for the U.S. economy. The U.S. leads the world in this sector with annual American exports of medical device and biotechnology products currently exceeding $6 billion.

What's going on in Connecticut?

According to the Connecticut Business and Industry Association (CBIA), the number of biosciences companies in the state has grown from four to 40 in the last 10 years.

BME is being fostered by Connecticut nonprofits, healthcare organizations, academia and industry.

Dr. Joseph D. Bronzino heads the Hartford-based Biomedical Engineering Alliance and Consortium (BEACON), a nonprofit trade association comprising academic, clinical and corporate partners. The organization is dedicated to developing and commercializing new medical technology, including BME.

"We want to foster an environment in Connecticut that encourages collaborative research, stimulates industrial partnering and facilitates the creation of new medical technology, companies and jobs," he said. "To accomplish these goals, we provide BEACON members with access to expertise and resources within our network."

Tom Ellen, chief executive officer of Vivax Medical in Torrington, Conn., is a member of BEACON. Vivax, a startup company, develops noninvasive medical devices that offer care advantages to patients and caregivers with a simultaneous potential for dramatic decreases in healthcare costs. For example, the company has developed a mobility system that can automatically transfer a patient from bed to wheelchair and vice versa. "For more than a century, industry has been undertaking productivity improvements," Ellen said. "Now similar improvements are coming to health care."

For startup companies, like Vivax, the biggest issue is capital. "There is a fairly well-developed venture capital system in the United States," Ellen said. "But, many good companies with great ideas can't get funding because

they don't provide a big enough return for venture capital companies. If Connecticut is serious about fostering development of business and hiring, the state needs to join the other states that currently provide a source of money to support worthy early-stage startup companies."

In 2001, the University of Connecticut (UConn) was the first public university in New England to offer an undergraduate program in Biomedical Engineering. In just three years, the program has grown to almost 200 students. Projections indicate it will grow to 400 students within the next three years.

According to Dr. John D. Enderle, program director for BME at UConn, the undergraduate program is very hands-on and offers students experience with the latest tools as well as the advantage of the school's 40-year history of graduate-level education in BME. "The hallmark of both our graduate and undergraduate programs in BME is the hands-on experience and variety of courses we offer," he said, noting that the undergraduate program offers six different tracks and numerous elective BME courses.

In a unique twist, UConn offers select freshmen the opportunity to apply for acceptance into the UConn School of Medicine. "This allows us to attract superstars who want to be guaranteed a spot in medical school from the outset," Enderle said. "These students want to be involved in summer internships and to conduct research as part of their undergraduate experience. Because of our established relationships with area hospitals and our unique association with the UConn Health Center, our students can work in a faculty lab and can conduct joint research projects easily within our existing infrastructure."

Students in the school's undergraduate program also participate in the National Science Foundation (NSF) Engineering Senior Design Projects to Aid Persons with Disabilities. Students construct custom-designed devices and software for people with disabilities. "The NSF pays for all parts and we give the product to the person free of charge," Enderle said. "The impact is huge because even a small project would cost a person $50,000 or more. Our students gain experience and the community is beginning to understand the direct impact of BME on individual lives," he said.

What does the future hold?

Members of the state's clinical, industrial and academic communities agree that BME holds tremendous potential for future job growth.

A recent BEACON report completed with support from Northeast Utilities (www.hartfordspringfield.com) indicates that Connecticut's infrastructure is poised to support growth in the medical device sector of the economy. "Of particular importance is the presence of a number of precision manufacturing companies that are diversifying to accommodate the medical device industry," Bronzino said, adding that he hopes this trend will be encouraged and supported. "Our state needs high-tech jobs and BME professionals are almost all highly educated and highly paid. Significant growth in this sector would be multiplied five-fold in the state's service industries."

According to Pete Gioia, economist at CBIA, "Industry projections suggest that there will be more than 80 biosciences companies in Connecticut within the next 10 years." That figure is double the number of bioscience companies active statewide today.

Enderle notes that pharmaceutical and biotechnology companies have a strong presence in Connecticut. "We also have small medical device companies which I believe will be the foundation for BME growth in Connecticut," he said. "Small companies that build new products in niche markets will become larger and continue to grow. The growth will steadily build."

Noting that the U.S. population is aging, with recent projections indicating 70 million Americans (or one in five) will be age 65 or older by the year 2030, Yeston says that the potential job market is enormous for people with the right combination of knowledge and creativity. "Today's older people want to be active," Yeston said. "With BME, we may one day be able to provide brain implants or neurosurgery advances to counteract diseases like Parkinson's for example.

“It might sound ridiculous, but BME can provide us with a real opportunity to make safe and long-lasting replacement parts,” Yeston said. “BME has the potential to make man bionic.” — ***Karen Cohen, science writer and owner, The Write Stuff, Hebron, CT***

Editor’s note: The BEACON Conference and Exposition – MEDi 2005 – a conference where medical technologies, life science research and industry will converge is scheduled for Oct. 25-26, 2005 at the new Connecticut Convention Center in Hartford, Conn.

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