

## PROJECT SUMMARY

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We request funding to initiate a new scientific enterprise, a Bioengineering and Medical Science (BEAMS) Center, to bring together established, outstanding programs in engineering and biomedical science at the LSU College of Engineering in Baton Rouge and the LSU Eye Center. The BEAMS Center will integrate these programs into a synergistic research and academic force in bioengineering and the medical sciences. The BEAMS Center will target the following three major research areas: 1) **Cell and Tissue Engineering**, 2) **Bio-form and Function**, and 3) **Bio-MEMS and Intelligent Biodiagnostics**, and will create an outstanding training and educational outreach program. The state-of-the-art BEAMS Center will foster new research and biotechnology opportunities, develop technically trained manpower for Louisiana, and to have a total economic impact of more than \$100 million. The Center's research efforts will target four diseases of particular concern in Louisiana: heart disease, glaucoma, cancer, and diabetic retinopathy, with a special focus on developing new methods for their diagnosis and treatment.

**Cell and Tissue Engineering** projects will utilize engineering and medical principles to engineer substrates for cells and tissues that will enhance our ability to bioengineer repair of tissue and replacement of diseased or aging body parts. **Bio-form and Function** projects will develop quantitative models of tissues and organs. Studies will focus on the mechanical forces in cell functions and tissue remodeling and on increased understanding of cell injury and tissue dysfunction. A second objective is to use engineering principles to understand the electrical activity of the heart and to uncover the mechanisms by which the heart's mechanical and electrical activity affects treatment of cardiac arrhythmias. **Bio-MEMS and Intelligent Biodiagnostics** will develop new computational tools for biomedical microsystems, and medical bioinformatics, and decision support systems. The Center will utilize the resources of the LSU, J. Bennett Johnston, Sr., Center for Advanced Microstructures and Devices (CAMD) to fabricate micro-electro-mechanical (Bio-MEMS) systems that continuously measure pressure within the patient's eye; to deliver medications; and to analyze bone structure. Specifically, we will develop both a microsensor to monitor intraocular pressure and microdrug delivery systems to deliver drugs to the retina. We will also develop micro-strain sensors to characterize bone adaptation. Research in the area of medical decision support software systems will work towards development of a hyperspectral imaging and analysis system to extend our work in non-invasive, optical biopsy. Hyperspectral imaging is effective in detecting disease processes such as cancer and infection by measuring tissue response to light over different frequency bands. Development of intelligent medical diagnostic decision support systems to extract information from time varying networked medical databases, and biosensors has wide-ranging potential. BEAMS Center research will develop effective screening for diseases such as diabetic retinopathy and will create new software systems for data mining and medical bioinformatics using neural network theory, mathematical logic, discrete optimization, and statistical analysis.

An **Academic and Outreach Program** in biomedical engineering targets K-12, undergraduate, and graduate students and physicians for training to foster technology in Louisiana.

Overall, the BEAMS Center will actively develop and contribute to the state's biotechnology/industrial base and successfully compete for multi-million dollar federal grants.

### **The Vision for the Center**

We are requesting funding to initiate a new Bioengineering and Medical Science (BEAMS) Center to advance research and education in the bioengineering and health sciences. Recognizing that basic research in biomedical engineering differs from research traditionally conducted at engineering and medical institutions, Congress recently established a National Institute of Biomedical Engineering and Imaging at the National Institutes of Health (NIH). Biomedical engineering integrates biomedical research with engineering to develop new materials, processes, sensors, and analysis procedures for the prevention, diagnosis, and treatment of disease. The announcement of the new NIH institute also recognized that basic research in biomedical engineering is crucial to improving health care. The BEAMS Center will be both a program and recognized center with a physical setting, and will take advantage of established, outstanding programs in engineering and biomedical science at four major state and private universities to advance vigorous, pioneering research and education. As shown in Figure 1, the BEAMS Center will integrate these strong programs into a synergistic force promoting research and academic programs in bioengineering and the medical sciences that are able to successfully compete at the national level for research grants and to stimulate biotechnology in Louisiana.

### **Multidisciplinary and Multi-Institutional Research Collaboration**

The BEAMS Center will take advantage of the outstanding programs that have been established in engineering and biomedical science in the College of Engineering (LSU, Baton Rouge), and the LSU Eye Center (LSUHSC, New Orleans). The BEAMS Center will integrate existing programs into a synergistic force to promote research and academic programs in bioengineering and the medical sciences.

### **Interdisciplinary Educational Programs**

The BEAMS Center will recruit students from engineering and medicine to apply their skills to biomedical engineering practice. Program graduates need to communicate and work effectively in teams and develop broader interdisciplinary perspectives and problem-solving abilities required to advance the overall biomedical field. The Education and Outreach Program will combine interdisciplinary and multi-university academic and research opportunities from the participating universities to develop graduate education and outreach programs in bioengineering. The Center will develop Master's and Ph.D. degrees that allow students to develop academic and research programs with professors from any of the participating universities. Graduate and undergraduate students will work on interdisciplinary research teams and may be mentored or co-advised by faculty from the participating universities. Bioengineering courses will be offered through distance learning and/or web-based systems to students at all participating universities and made available as course modules to non-participating institutions. The educational thrust of the BEAMS Center will touch all levels: K-12, undergraduate, graduate, post-graduate, and the current workforce.

### **Advances in Health Care Sciences**

The Center's Intelligent Biodiagnostics research projects will develop new software systems for low cost and efficient, biomedical information processing to aid disease screening and clinical management. Efforts will focus on integrating medical imaging data with other patient data and to make this new information available through a local area network (LAN) between state institutions, particularly public hospitals and universities. New methodologies developed by the BEAMS Center will be adaptable to systems for medical decision support. They will be augmented by tools developed through computer engineering, such as intelligent database applications and knowledge discovery software used for both rule discovery in the classification of patient data and the computation of risk assessment. Patented product development of integrated software and hardware tools for improving care, especially in populations now underserved by medical specialists (such as retinal fellowship-trained ophthalmologists), will be a positive research outcome.

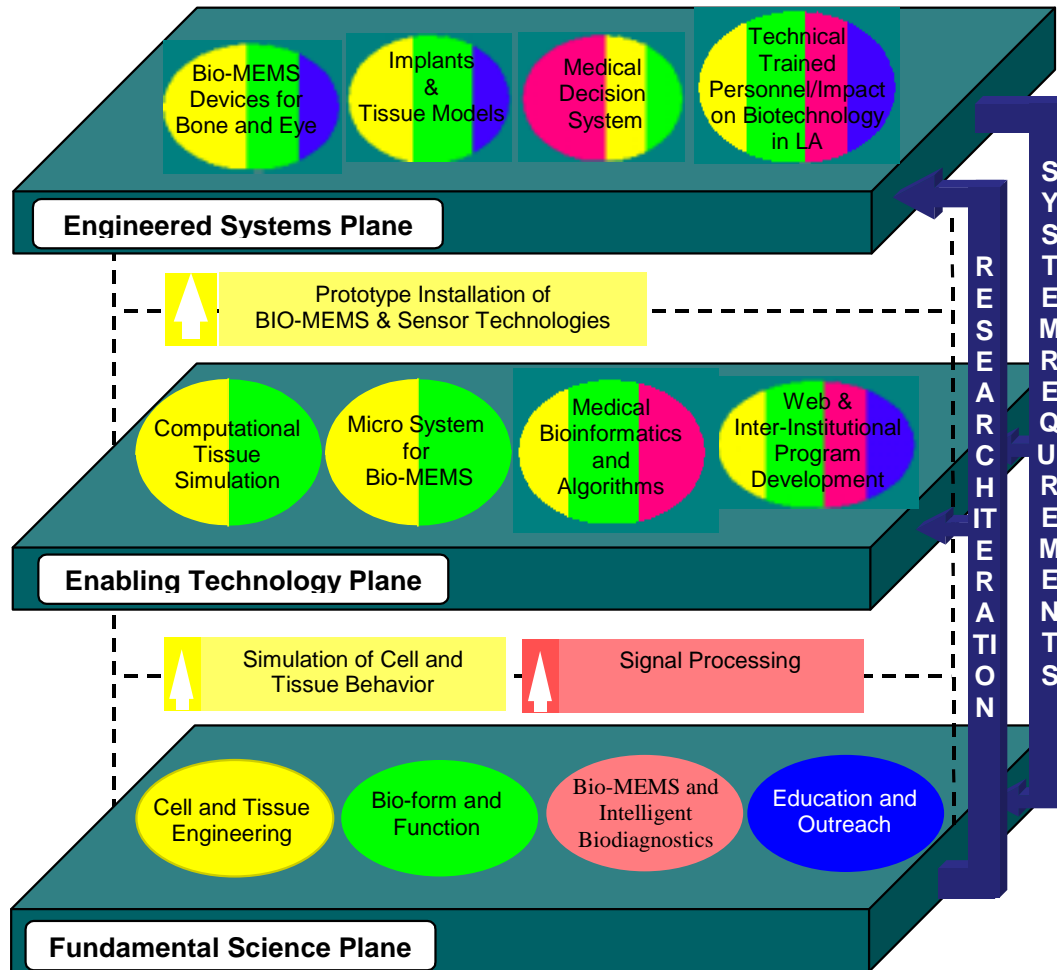


Figure 1. Bioengineering and Medical Science (BEAMS) Center

**Economic Development**

Overall, the BEAMS Center will provide a framework and serve as an industry resource to significantly contribute to the growth of Louisiana’s technology-based industry. The BEAMS Center will enhance biomedical, information, and micromanufacturing technologies, while its research and academic programs will increase Louisiana’s manpower base of engineers, scientists, and technologically-trained doctors. Industrial outreach programs will support and promote entrepreneurship and industrial development.

Bioengineering and the health sciences are large, dynamic industries with great potential for economic development. For example, an estimated one million laser assisted (LASIK) eye surgeries were performed in 2000 with twice that number expected in 2001. LASIK surgery is predicted to become one of medicine’s most common surgical procedures, with the LASIK market predicted to grow from \$110 million in 2000 to as much as \$750 million by 2005. A crucial contributor to this growth will be the development of new instrumentation. Researchers at the LSU Eye Center are among the nation’s leaders in the development of refractive surgery and optical diagnosis instruments. The BEAMS Center will capitalize on this success and optimize the chances for development of new instrumentation and other tools. Biomedical engineering is a developing technology with tremendous economic impact, including the potential to provide many future jobs. Strengthening the university programs in this area is an important link in developing the economic base in bioengineering and medicine. A lack of attractive, well-funded educational and research programs limits the growth of Louisiana’s biomedical industry. Nonetheless, industry growth depends upon strong university programs, and biomedical companies are attracted to universities with environments that foster such research. A brief Internet search finds 40 companies engaging in tissue engineering, for example; by developing research facilities such as the BEAMS Center, it is far more likely that companies such as these will be attracted to Louisiana.