Biological Engineering Contribution to Biocomputing (IT) Initiative:

Many design courses implemented in biological engineering consider application areas such as bioprocessing, bioreactor design, environmental processing, transport phenomena and biomechanics. These subjects lend well to computational techniques required to solve common relationships such as the familiar laws of conservation. The approach of mathematical design in these important courses also require rate equations for enzyme and microbial kinetics, governing conservation relationships, and geometric and structural relationships in biomechanics. Application of computational techniques are becoming common-place for practicing engineers. Some of these techniques include computational fluid dynamics (CFD), finite element methods (FEM), and bioinformatics and are rapidly becoming the primary methods to aid in the solution of a vast number of biological and engineering problems and applications.

Recently a large number of institutions have developed programs of study with emphasis on the interface of engineering with the biological sciences. Some of these integrated areas include biological, biomedical, biochemical, agricultural, environmental and biomechanical engineering. The mathematics associated with biological systems is complicated by the heterogeneous nature of these systems that requires the rigorous solution techniques of computational analysis. Finite element theory achieves the greatest solution accuracy for many complex systems. Also, the natural applicability of finite element analysis for solving multidimensional problems makes this technique a highly desirable tool to tackle the complexity associated with biological systems.

Bioprocess engineers often deal with complex heterogeneous systems characterized by non-Newtonian behavior. Solution integrity becomes of great concern

for the systems of partial differential equations describing these challenging effects to better simulate these systems in the design process. An example is the design of a fungal bioreactor that addresses variable cell-dependent, non-Newtonian flow for submerged cultures requiring varying degrees of oxygen, which depend primarily on cell morphology and concentration. Simultaneous convective heat transfer effects may occur due to many possible exothermic biochemical reactions within microorganisms. In the past, problems of this origin were restricted primarily to supercomputers. Recently, with the advent of competitive technological advancements for desktop computers combined with user-friendly computational software, the problem-solving tools are rapidly becoming available to the engineers' desktop.

Objectives and Collaborative Efforts:

Collaboration is anticipated within the biocomputing initiative with other departments in the LSU system (Mechanical, Chemical, Electrical Engr., Computer and Biological Sciences, and LSU Medical School) and the CFD Laboratory located at the University of Tennessee. These collaborations will be vital to the success of the overall biocomputing initiative. The primary objective of the role of Biological Engineering will be to broaden the proposal to include biocomputing aspects in bioprocessing such as application of numerical techniques in bioreactor systems, supercritical extraction systems, etc, to enhance the overall project that should also include objectives for biomedical/biomechanical and bioinformatics applications.

LSU College of Engineering and College of Agriculture have implemented high-quality distant education facilities throughout the campus for communications within and outside of Louisiana. The UT CFD laboratory contains state-of-the-art facilities for

computational finite element analysis that has been well established over the past two decades. The ability to communicate readily between departments, universities, etc. such as use of instructional media with streaming video via internet has enabled the possibility of a highly-collaborative computational environment.

The hiring of one faculty member to enable a strong effort in biocomputing for bioprocessing applications is greatly needed. Presently, a post-doctoral personnel is handling the duties in the Dept. of Biological and Agr. Engineering at LSU, but funding from a present USDA Higher Education Challenge grant under the direction of Dr. Terry H. Walker will terminate in one year. A new faculty member with expertise in biocomputing would greatly complement the present faculty in biological engineering who have interest in bioprocess computing.