

PREFACE

This book is written for two purposes: to give beginning students a sampling of the contemporary bioengineering, and to cultivate in the minds of students a sense that engineering is invention and design, is creating things that have never been. Engineering science is the study of nature and humanity quantitatively so that engineering design is made possible. Bioengineering is engineering of living organisms. Bioengineering is very popular, and we have a large number of bright young students. Yet most of them have no idea what engineering is. They think they are majoring in bioengineering, but the University tells them to take more courses in humanities, math, physics, chemistry and biology. Later they will take engineering courses which, at this time, are usually taught very much like traditional math and science: with good lectures, logical presentations, polished derivations, lots of exercises, but no mention of invention. My feeling is that invention and design is the essence of engineering. Invention and design can be taught. A habit of inventive thinking can be cultivated. And the cultivation should begin as early as possible, by demanding the students to invent, and to develop their inventions by design. Hence in this introductory course I ask the students to invent and to design. Invent something, maybe a better mouse trap, a new gadget, a new medical device, a new material, a new drug, a new method, a new instrument, a new experiment, a new theory, a new concept, a new approach. Each new idea needs to be crystallized by a design. I give them assignments to design step by step. They will soon realize that the method must be scientific, and that the real limitation to any important invention is the lack of knowledge. By wanting to invent, they realize that they need to master the classical subjects. Thus the classical subjects become alive, and the study becomes active. Thus I lay great emphasis on the first few pages of this book. The assignments given to the students are the heart of the course. Reading and commenting on the students' papers is the job of the instructor and teaching assistants.

After initiating the student to invent and design, we show them live examples in person of their faculty members. These examples constitute the body of this book. Each example consists of a lecture and a paper. The lecture tells what a faculty member is doing. The paper is the best publication of the speaker. Therefore, this book is not a run of the mill *Introduction* that is supposed to be easy to read and undemanding. Some of the papers selected here are indeed easy to understand. Some others are quite technical and may not be easy to assimilate without proper preparation. All are "advanced" in the sense that they represent a part of the current frontiers of knowledge.

Not everybody likes the inventive approach or the subject of bioengineering. This course may persuade some of the students to choose a different career goal. Our experience in this introductory course has been very satisfying. The final reports handed in by the students are often remarkably well done. Nice, fresh ideas abound. You can see that the inventive chord in the student has been plucked.

The authors and I feel the urge to publish this book because we believe that engineering education needs a qualitative lift. We need to challenge young engineering students to think their own thoughts. We need to bring inventive thinking to the fore. We need to give engineering courses a new spirit, to teach invention, to cultivate independent thoughts, to use science as our tools and to enjoy science the same way as we enjoy humanities. We give

an example here in the subject of bioengineering. Any department in any university can easily remodel our example presented here to suit its own image and ambition.

Recently, several books have appeared bearing the title *Introduction to Bioengineering*. Most of them are big tomes. I cannot see how an instructor can use them to teach a course for the beginners. This book, however, is aimed at the beginner. It has been tried out several times at UCSD, and have been found exciting. We invite other institutions to try it for their students.

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Editor