SECTION I

Engineering philosophy

Thomas A. Edison, recognized as one of mankind's most talented inventors, once said, "Genius is one percent inspiration and ninety-nine percent perspiration." In uttering this statement he failed to recognize another important ingredient. There are many brilliant technicians who have untold inspirations, and there are many who perspire a good deal—oftentimes the same individuals. But this combination of inspiration and perspiration does not necessarily result in the product of "genius." Continuing the premise, if one examines the field of engineers, from students to experienced practitioners, one finds that often the most brilliant or talented, from the standpoint of fundamental knowledge of the relevant engineering sciences, is not necessarily the one who displays the most productive creative ability, although all those considered may perspire an equivalent amount. The difference, the third ingredient, could be called the *necessary philosophy* or *attitude.*

This philosophy cannot be wrapped up in a simple small package and distributed to the engineering student. Psychologists may study its existence and debate whether its possession is a result of inheritance or environment. Many have often heard the expression "Engineers are a strange breed," a statement which, indeed, has a basis in fact. An engineer is as much a creative artist as a painter or a sculptor. A "good" engineer is, indeed a master artist. Using only the laws of physics and chemistry as his brush and canvas, and the material resources of the world as his paint, the engineer "creates" machines, systems, gadgets, and devices that become such a common part of one's existence that we scarcely notice them. It is as if Vincent van Gogh not only created his masterpieces but developed a machine to make a perfect reproduction available to all who desired one!

Most engineers may not consider themselves as creative artists, but if they are not creative, they are not fulfilling the most rewarding role of the engineering profession. Probably the most notable example of this analogy in history is Leonardo da Vinci (1452–1519) who indeed is considered one of the greatest artists *and* engineers of all time. This was not unusual during the Renaissance era. Although all engineers have not been gifted with the talent for painting or sculpture, all good engineers have developed the philosophy to use the tools at their disposal, as did da Vinci, to develop or create the most desirable or useful engineered product as the charge may be given him. This product could be a bridge, a thermodynamic machine, or a household device. The products of such engineering genius have done infinitely more to change the destiny and life-style of mankind than have the works of the greatest masters of the arts.

This section includes some discussions on various concepts of engineering philosophy. Hopefully, the reader can start piecing the puzzle together from the content of the chapters in this section. From these chapters one will recognize that to be a successful or creative engineering designer first requires a thorough knowledge of the relevant laws of physics and chemistry. Without this knowledge, the engineer is like the painter without a full inventory of paints. From this starting point, it may be that the pieces of the puzzle are endless (that is to say that anyone who held all the pieces would essentially possess the secret of life). The discussions, however, are intended to include some of the key pieces—certainly enough to point out the proper direction.

If the knowledge of the physical principles could be considered the foundation, the cornerstone would be curiosity. Curiosity not only for its own sake, but as it relates to the chore at hand. The good engineer is never satisfied with a lack of thorough understanding of the problem. If he encounters a problem which he does not understand, he will not simply rest comfortably with the "assurance" of a colleague. He will question, study, and research until he possesses the understanding and the knowledge that he is comfortable in this understanding.

But the building is not constructed of a foundation and a cornerstone alone. And the point of this discussion is to illustrate that the foundation does not a building make! Other component parts, properly placed are necessary.

The chapters in this section start with a discussion on the difference between pure and applied science. The reason this topic was authored is that many engineering efforts have become deadlocked in the arguments of thorough scientific understanding. From this introduction, several other key ingredients are presented such as simplicity, the use (or misuse) of so-called rules of thumb, how neglect of minor details leads to design failures, with the final chapter in this section addressing the economic question—can our economic system afford the price of engineering?

The chapter on the "New Energy Technology" is intended as a lesson to the engineering practitioner to recognize the true components of the "big picture," but also presents a message to those who would look for greener pastures across the fence, when the finest fodder is beneath their feet.