



## Engineering by Design (2nd Edition)

*By Gerard Voland*

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### **Engineering by Design (2nd Edition)** By Gerard Voland

The book introduces readers to a broad range of important design topics. It provides numerous cases that illustrate both successes and failures in engineering design; qualitative presentation of engineering practices are easily understood by readers with little technical knowledge, and analytical techniques are given that allow the development and evaluation of proposed engineering solutions. Coverage includes: an overview of engineering design, needs assessment, structuring the search for the problem, structuring the search for a solution (design goals and specifications), acquiring and applying technical knowledge, abstraction and modeling, synthesis, ethics and product liability issues, and hazards analysis and failure analysis. An excellent handbook for design engineers.

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## **Editorial Review**

From the Back Cover

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### About the Author

Gerard Voland has taught design for 20 years and pioneered an innovative, nationally recognized freshman design course at Northeastern University. In 1994 he was named the George A. Snell Professor of Engineering in appreciation for his work with this freshman design course and with engineering curriculum reform at Northeastern. He is also the author of textbooks on engineering graphics and control systems modeling. He lives in Bridgewater, Massachusetts, with his wife, Margaret Voland, a mathematician who researched and developed the case problems in this book.

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## **Rationale for the Text**

*Engineering by Design* is intended to serve a multiplicity of functions while conveying the excitement and sheer fun of solving technical problems in creative yet practical ways. It provides an introduction to the engineering profession through numerous case histories that illustrate various aspects of the design process. This is important because students can come to appreciate the interdisciplinary aspects of engineering problem solving as they work with case problems or review case histories in design which demonstrate (sometimes in a very startling but effective manner) valuable lessons in engineering practice.

Many engineering colleges are continuing to revise their curricula in response to the ABET 2000 accreditation requirements. Various design and manufacturing topics are being integrated more into undergraduate engineering programs, and new mechanisms for delivering this course material are being developed with a general focus upon experiential learning by undergraduates. *Engineering by Design* has been developed as an aid for these important efforts. It is written in a way that I hope will be both engaging and accessible to students while maintaining the accuracy and rigor that one would expect of an engineering textbook.

Freshmen and sophomores often have little substantive knowledge of professional engineering practice; indeed, these students may have many misconceptions about the actual work that engineers perform and the types of problems with which they wrestle. The initial chapters and case histories of this book will give students a limited but informed understanding of the engineering profession. Later material (including case problems through which students can apply their newly acquired knowledge of design) then broadens and deepens this understanding, and this material can be used in a wide variety of courses including senior

capstone project classes. A list of appropriate courses is given later in this preface.

Through this approach, students discover the need to

- formulate problems correctly
- work successfully in interdisciplinary teams
- develop their creativity, imagination, and analytical skills
- make informed ethical decisions
- hone their written and oral communication skills

Most important, they learn that engineering is a service profession, dedicated to satisfying humanity's needs through responsible, methodical, and creative problem solving.

This second edition of *Engineering by Design* includes expanded coverage of several important topics, including teamwork skills and tools, Gantt charts, problem formulation strategies, engineering graphics and sketching, and creativity stimulation techniques. Moreover, numerous additional case histories have been incorporated into the text.

## Structure

### Case Histories

*Engineering By Design* introduces students to such critical design topics as needs assessment, problem formulation, modeling, patents, abstraction and synthesis, economic analysis, product liability, ergonomics, engineering ethics, hazards analysis, design for X, materials selection, and manufacturing processes. The engineering design process provides the skeletal structure for the text, around which are wrapped numerous case histories that illustrate both successes and failures in engineering design.

According to Larry Richards, Director of the Center for Computer Aided Engineering at the University of Virginia, engineering cases generally fall into one of three categories. They are case studies, case histories, and case problems. A *case study* presents an ideal or benchmark solution that may serve as a model for future work. In contrast, a *case history* describes how a problem was solved, and points out the consequences of the decisions that were made. This text contains numerous case histories; the more extensive ones have been collected at the end of each chapter so that they will not interrupt the flow of material in the chapters. Each case history has been selected to illustrate a particular principle, procedure, or lesson in the text. Students and faculty can use these case histories as important resources for study, reflection, and discussion.

### Design Project Assignment Template

The text ends with a unique *Design Project Assignment Template* (immediately following Chapter 11) that the instructor can use to select and assign tasks to students who are working on a design project. With this template, instructors can directly correlate their students' efforts on a project with appropriate material from each chapter of this text. Of course, not all assignments need to be performed; the template provides a "menu" from which instructors can select tasks and topics that they wish to emphasize.

This template also provides an abbreviated summary of the text with key concepts highlighted in **bold** type. Students can use this template to review and correlate the critical elements of the design process as they develop an overall perspective of the material presented throughout the text. If a term or concept in the template is not understood completely, the student should recognize that lack of understanding or comfort with the concept as a warning flag. The student should then return to the (referenced) section in the text in

which the concept is discussed and study further. Through such efforts, the template can serve as an important learning aid. A sample section of the design template is shown in Figure P.1

## **Case Problems**

Finally, a *case problem* sets forth an open-ended (perhaps unsolved) situation that leaves the solution up to the reader. It can be a learning module designed to put students to work in teams to define the problem and solve it through research, discussion, and/or lab work. Four extended case problems have been prepared for use as active learning modules; they follow the Design Project Assignment Template. Each of these case problems contains a substantial amount of background information, as well as proposed or existing solutions, so that students will be able to "hit the ground running" if any of these problems is chosen for a design project.

Moreover, these case problem modules serve as examples of the depth, breadth, and type of information that one should acquire about a technical problem before embarking upon the development of a design solution. The background material in each problem provides sufficient information to understand the general parameters and factors that must be considered during a design effort; however, students should seek additional information beyond that contained in the case problems.

Immediately following the four case problems is a list of *50 case problem topics*, which describe situations that call for engineering design solutions. Since these descriptions are very brief, students will need to research the background and current status of each situation. Again, the four extended case problem modules described above can serve as examples of the type of background data that should be collected via such research.

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