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Collecting to the Core-Popular Engineering Works

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Collecting to the Core — Popular Engineering Works

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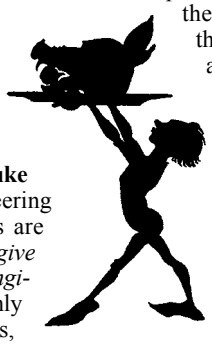
Column Editor's Note: *The "Collecting to the Core" column highlights monographic works that are essential to the academic library within a particular discipline, inspired by the* ***Resources for College Libraries*** *bibliography (online at* ***http://www.rclweb.net****). In each essay, subject specialists introduce and explain the classic titles and topics that continue to remain relevant to the undergraduate curriculum and library collection. Disciplinary trends may shift, but some classics never go out of style. — **AD***

Much of engineering involves the straightforward application of science to the creation of products and systems. To support engineering in a college library, librarians need to provide the most current monographs, reference books, and research papers. But the library's monograph collection should also encourage students to explore the philosophical side of technology as they learn to be engineers. What is good design? What can be learned from past engineering failures? What unintended consequences have technologies produced? This essay discusses a selection of ten key books that address these questions.

The first two titles explore engineering design as a creative process. *Designing Engineers* is a unique 1995 "study of engineers at work" by **Dr. Louis Bucciarelli** of **MIT's Program in Science, Technology and Society**.[1] This in-depth ethnographic study of the creative design process in three engineering firms provides a window into the real world of engineering and was called an "important, thought-provoking, and seminal book" in *Choice*. By attending actual meetings and talking with engineers and managers, **Bucciarelli** observed three projects: design of solar panels for a desalination system; design of an X-ray imaging inspection system for airport security; and design of a machine for processing and producing hardcopy prints of photographs. In each of these projects there are many engineers handling different aspects of the design and working together to connect the pieces successfully. Engineering students will appreciate the insight into daily working life in engineering firms and gain a greater understanding of how engineers create designs in actual environments.

Because invention is more of an art than a science, it is often overlooked as a subject for serious study by engineers. *The Art of Invention*, a 2010 *Choice* Outstanding Academic Title, fills this gap well.[2] This readable, up-to-date paperback, written by successful engineer and inventor **Steven Paley**, offers both inspiration and practical advice to young engineers. There are three parts: "The Process of Invention;" "Design and Invention;" and "Making it Happen." In "The Process of Invention," **Paley** details the genesis of real inventions to illustrate how "immersing yourself in the basics of physics, chemistry and biology," defining the problem specifically (but not too rigidly), and then letting the creative process take its course can result in unexpected success. In "Design and Invention," he explains why designers should strive to create products and processes that are simple, elegant, and robust. "Making it Happen" is devoted to the business aspects of invention: how to patent, finance, and develop your invention.



An important aspect of engineering design is learning from past failures. Toward that end, every engineering collection should include books by **Dr. Henry Petroski**, a professor of civil engineering at **Duke** well-known for his popular engineering works. His most important books are *To Engineer Is Human* and *To Forgive Design*.[3-4] The motivation for *To Engineer Is Human* was a string of highly visible structural failures in the 1980s, which led to public questions about engineers' training. **Petroski** explores the many risks and trade-offs of the engineering design process, which incorporates the best science available but also includes fallible humans and the truth that every built object will eventually fail. He uses major news stories, analogies from everyday life, and even poetry to make his points. For the undergraduate engineering student, this book is important because it places the practice of engineering in reality, including malfunctions. In the sequel published twenty years later, *To Forgive Design* (a 2012 *Choice* Outstanding Academic Title), **Petroski** further explores the human causes of engineering failures. He begins by considering what can be learned from fatal catastrophes like bridge collapses in order to avoid them in the future. But while the earlier book focuses mainly on design issues, the sequel tackles construction shortcuts and corruption, management incompetence, and other ethical issues. **Petroski** suggests that the Canadian practice of ceremoniously bestowing the Iron Ring on newly graduated engineers may make them more aware of the social responsibilities inherent to engineering work. For student engineers, **Petroski** emphasizes how important it is to be aware of the discipline's history and rationale behind design choices, in addition to keeping up with the latest research.

In recent years the engineering field has begun addressing the increasingly serious global environmental and climate issues. Part of this includes the movement toward "green" design and manufacturing. While a good engineering collection should have many titles covering these topics in detail, students can also benefit from high-level overviews of how engineering can help solve ecological issues. *The Essential Engineer: Why Science Alone Will Not Solve Our Global Problems* "strives to clarify the often hazy distinction between science and engineering, thereby making it clearer what [engineers] can and cannot do about ameliorating global risks" such as global climate change, asteroids hitting the earth, or holes in the ozone layer.[5] In this book **Petroski** focuses on explaining the important ways in which engineers differ from scientists. Because the two professions are often lumped together by the media, people frequently confuse their roles. Scientists study problems and report on their results, while engineers try to design solutions to the problems. With this ability to act comes responsibility, since action can have negative or positive consequences. **Petroski's** work illustrates that engineers need to be able to assess the risks and benefits of action and not base design solely on technical feasibility.

In *Cradle to Cradle: Remaking the Way We Make Things*, architect **William McDonough** and chemist **Michael Braungart** report that many of the chemicals used in the manufacturing of products not only endanger health during their useful life, but also occupy landfills where they contaminate the groundwater supply.[6] Often products are a hybrid of organic and inorganic materials that cannot be easily separated, so the entirety ends up in a landfill. **McDonough** and **Braungart** argue that waste should either be biodegradable or useable in making new products so there is a continuous "cradle to cradle" cycle. The book itself, which is made out of waterproof plastic, is an example of the manufacturing changes they are promoting. Published in 2002, it was among the first scholarly works to discuss the human consequences of product manufacturing. The *Choice* reviewer of this book said simply, "Everyone should read this!" The authors present far more than an exposé of problems, proposing detailed guidelines for "eco-effective" manufacturing to improve the harmful ecological impacts of product creation. For students embarking on careers in chemical or manufacturing engineering, this is an important and very relevant book.

In today's world, much of engineering involves large and often diverse groups of people managing complex projects and systems. Naturally, competing interests and ethical issues often arise, and the spread of subcontracting and global supply chains has multiplied the possible pitfalls. In the 1997 book *Engineering Ethics: Balancing Cost, Schedule and Risk – Lessons Learned from the Space Shuttle*, **Rosa Lynn Pinkus** and her coauthors use the familiar space shuttle

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Challenger tragedy as a case study for understanding engineering ethics in large projects.[7] Every engineering project must meet multiple goals for success such as cost, schedule, and quality. Of course these goals frequently conflict, and engineers and managers have to determine how to balance them and complete the project successfully. Accidents like the Challenger explosion can often be traced to situations where management focused on cost and schedule and ignored quality and safety concerns raised by engineers. This book addresses both organizational issues like power, autonomy, and "whistle-blowing," and technical issues engineers face like testing philosophies, reliability, and redundancy. The detailed case studies showcased here provide insight into how different people handle ethical decision-making and what the consequences can be.

Another danger inherent to the complex systems handled by today's engineers is the subject of the 2012 book *Interop: The Promise and Perils of Highly Interconnected Systems*.[8] **Harvard** attorneys **John Palfrey** and **Urs Gasser** explain that the increasingly large role electronic systems occupy means that interoperability between systems is becoming ever more critical. For example, the automation of health care records raises many issues of interoperability between the computer systems of disparate providers. Yet complete interoperability is not always ideal since there are essential issues of privacy and security involved. Human oversight can be an important protection against systems that become too interconnected (such as our global financial system). **Palfrey** and **Gasser** reveal the pros and cons of interoperability in a variety of modern systems and the impact on consumers, corporations, and governments. This is an issue which future engineers, particularly electrical and computer engineers, will need to understand well in order to make appropriate decisions in their work.

Despite the best training — and intentions — throughout the creative and design process, technology can often have negative consequences. The iconic title in this category is **Edward Tenner's** 1996 book *Why Things Bite Back: Technology and the Revenge of Unintended Consequences*.[9] With an abundance of specific examples from all areas of technology (including medicine, agriculture, and sports), **Dr. Tenner** (formerly executive editor of **Princeton University Press**) uses his own powers of observation and a synthesis of the research literature to explain how various types of "revenge effects" occur. For example, computer keyboards speed up text entry compared to manual typewriters at the cost of increased repetitive strain injuries. Tall smokestacks mandated by environmental laws keep pollution out of the local air, but disperse it over a wider area, where it may do more damage through chemical reactions in the upper atmosphere. The book is a fascinating compendium, which will continue to be useful to those engineers and scientists who are wise enough to want to learn from the past. **Tenner** is surprisingly astute about the direction of science, technology, and ecology in the first decade of the twenty-first century, and only his discussions of computer hardware remind the reader that the book was published nearly twenty years ago.

The final book delves deeply into a very timely issue: the lack of security and privacy in modern electronic gadgets. **Robert Vamosi**, who writes about computer security for *PCWorld* and *Forbes*, presents clear evidence about the dangers of technological advances in his 2011 book *When Gadgets Betray Us: The Dark Side of Our Infatuation with New Technologies*.[10] He insists that Web-accessible computers and cell phones are not the only susceptible devices and reveals the vulnerabilities of various gadgets: hotel television remotes, smart meters, parking meters, and transit fare cards; iPods and tablets, digital cameras and music players; key fobs and locks; E-ZPass transponders, GPS systems, RFID tags, work badges, and ATM cards. **Vamosi** discusses the unknown personal data that is being stored and mined and what criminals, commercial entities, and governments can do with data, unbeknownst to users. It is critical that those engineers designing future electronic tools and systems understand both the vulnerabilities and the ethical issues at stake, though these are areas that engineering courses may not address.

Any of these ten monographs would be fine additions to an academic or public library's collection, since they appeal to students and engineering professionals, as well as to the layperson interested in the challenges, consequences, and social considerations at the core of engineering technology.

Endnotes

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6. **McDonough, William and Michael Braungart.** *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press, 2002.*

7. **Pinkus, Rosa Lynn B., Larry J. Shuman, Norman P. Hummon, and Harvey Wolfe.** *Engineering Ethics: Balancing Cost, Schedule, and Risk--Lessons Learned from the Space Shuttle*. Cambridge: Cambridge University Press, 1997.

8. **Palfrey, John G. and Urs Gasser.** *Interop: The Promise and Perils of Highly Interconnected Systems*. New York: Basic Books, 2012.*

9. **Tenner, Edward.** *Why Things Bite Back: Technology and the Revenge of Unintended Consequences*. New York: Knopf, 1996.

10. **Vamosi, Robert.** *When Gadgets Betray Us: The Dark Side of Our Infatuation with New Technologies*. New York: Basic Books, 2011.*

*Editor's note: An asterisk (*) denotes a title selected for *Resources for College Libraries*.