The Physicist as Quality Engineer

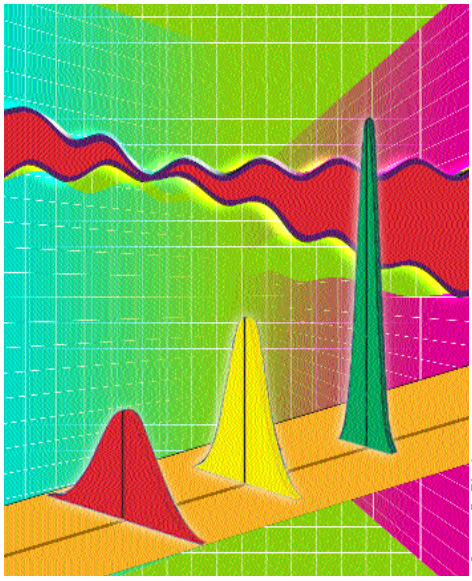
As a physicist working in industry, you almost certainly must become an engineer—at least in title. "Hidden" physicists have thrived in numerous engineering careers, as I have. My jobs, and their actual titles, have included software developer, manufacturing engineer, mechanical-design engineer, reliability engineer, project manager, and director of quality assurance. None of them has given me more satisfaction than working in quality engineering, which offers challenging problems and is intellectually and financially rewarding.

Quality engineering is vital in today's marketplace. Unless a company builds high-quality products, it will lose its customer base. Industry must practice both *quality control*, which is an inspection function to ensure that products work as intended, and *quality assurance*, the process that builds quality into a product. Quality engineers focus on quality assurance.

Physicists are well suited for the field because their analytical-thinking and problem-solving skills nicely match its needs. Consider this description from an American Society for Quality (ASQ) salary survey, which is based on the typical job duties of quality engineers:

> Designs, installs, and evaluates quality process-sampling systems, procedures, and statistical techniques; designs or specifies inspection and testing mechanisms and equipment; analyzes production and service limitations and standards; recommends revision of specifications when indicated; formulates or helps formulate quality policies and procedures; conducts training on quality concepts and tools; and interfaces with all other engineering components within the company and with customers and suppliers on quality related issues.

The field of quality engineering is diverse, and everyone's experiences differ. You might, as I have, find yourself in situations that involve many of the tasks listed in the ASQ job description. Once, a customer complained that parts were arriving in poorly secured shipping cases. At a meeting I called, manufacturing reported that the metal screws used in the plastic containers were stripping during assembly. Someone suggested using an adhesive to secure the screws. However, there was concern about compatibility of the case with adhesives. I volunteered to investigate the issue.



Steven R. Black

In a population of products aimed at a particular target quality in any particular process, there is a point of diminishing returns beyond which it does not pay to further reduce outliers.

During my research, I discovered that, although compatible with adhesives, the case material was ideal for ultrasonic welding. I found a laboratory that would weld samples for free. While awaiting the results, I did an analysis of the two operations, which showed that welding would reduce cycle time and have a lower scrap rate than adhesive bonding. I calculated that if the company purchased a welder, the machine would pay for itself in six months.

Ultrasonic welding got the green light, and I turned the implementation process over to design engineering and manufacturing. Then I got involved again during the welding-process development.

Diversity and authority

Quality engineers play important and diverse roles within and outside their companies. As a quality engineer, you start in middle management. In a typical midsize company, the quality engineer reports to the vice president or director of quality, who in turn reports to the company president. As an engineer in the same company, however, you might report to the project manager, who reports to the engineering manager, who reports to the director of engineering, who reports to the vice president of research and development, who reports to the president. Because you start higher on the corporate food chain as a quality engineer, your scope and level of authority are greater, and so is your salary.

According to the 2000 ASQ salary survey, quality engineers with less than one year of experience earned an average annual salary of $47,818. This is well above that of a starting engineer. As a physicist working in this field, you would naturally begin to develop expertise in one or more quality areas. This specialization would put you into the salary-survey category of consultant. The average salary of a consultant with 10 or more years of experience is $81,321.

In the quality realm, there are analysts, auditors, reliability engineers, software-quality engineers, and regulatory personnel, to name the most common positions. For all of them, physics provides a good technical background. For those interested in climbing the corporate ladder, quality engineers can advance to the rank of manager, director, and vice president.

To succeed as a quality engineer, you need to have a fundamental understanding of all areas of engineering (chemistry, software, mechanics, and electronics), which physicists have. An electrical engineer, even for an electronics manufacturer, may not have a sufficient background to interface with every department, from design through manufacturing, at a fundamental level. A physicist does. The ability to communicate at a knowledgeable level is what is truly required of a quality engineer.

Two routes of entry

Quality engineers usually enter the field in one of two ways—by chance or by choice. As a company grows, its managers may decide that they need a quality engineer. They look at who is available in the company, and then appoint the least productive engineer to the post. This scenario, unfortunately, happens more often than those of us in the field like to admit. The other route to quality engineering requires acquiring a specific body of knowledge. Once that knowledge is acquired, the individual will typically pursue certification through the ASQ as a certified quality engineer (the cost is about $150).

ASQ certification shows that a person has mastered the knowledge required to function as a top-flight quality engineer. To be eligible to sit for the exam, an individual must have, among other things, eight years of on-the-job experience in one of several specified areas, including at least three years in a decision-making position. A bachelor's degree in engineering or a physical science can serve as the equivalent of four years of experience.

ASQ certification, although desirable, is not a requirement to work as a quality engineer, and some people in the field never pursue certification. An entry-level job as a quality engineer typically requires a bachelor's degree in engineering, statistics, or a science (physics or chemistry, for example) and a general understanding of the prescribed body of knowledge, which the ASQ defines as the following:

- Quality practices and applications, including human resource management, quality planning, quality systems, supplier management, quality auditing, and continuous improvement/management tools.
- General knowledge of the quality field, including its benefits, standards, philosophies, and basic communications skills, and the ASQ's code of professional conduct and ethics.
- Statistical principles and applications, including terms and concepts, statistical distributions, statistical inference, correlation and regression analysis, experimental design, and acceptance sampling.
- Product, process, and materials control, including work instructions, classification of characteristics and defects, identification of materials and status, lot traceability, material review board criteria and procedures, sample integrity and control, and statistical process control.
- Measurement systems, including terms and definitions, metrology systems and requirements, repeatability and reproducibility studies, and destructive- and nondestructive-testing concepts.
- Safety and reliability, including terms and definitions, types of reliability systems, reliability-life concepts, risk-assessment tools, risk prevention, and product-trace-

ability systems and recall procedures.

Such knowledge is applicable to any company that does manufacturing. Unlike my master's degree in biomedical engineering, which limits me to the medical device industry, my credentials as a quality engineer allow me to work in any industry. As the importance of certification by the International Standards Organization (ISO) continues to grow in international commerce, so will the number of quality-engineering jobs. I frequently receive calls from "headhunters" trying to recruit me for quality-engineering positions. I have never received a call from a recruiter about an opening for a physicist.

Learning your way

Most quality engineers do not come right out of school. Until they meet their first quality engineer on the job, most engineers never know such an animal exists.

Although some schools offer quality-engineering programs, typically through the industrial engineering department, they are few in number. Most people acquire the knowledge they need through self-study (the option I chose), company-sponsored training, or ASQ courses. Numerous tools are available for self-study, which range in price from around $50 to $500. Another option is to take courses sponsored by a local ASQ section, which cost about $500.

Quality engineers are adept at problem solving and must understand statistical variability—important skills that physicists possess. You can enter quality engineering easily through self-study, and it offers many opportunities for advancement and professional recognition through additional certifications. Each new certification usually means an additional $5000 in salary. I am certified as a quality engineer, quality manager, and quality auditor, and I am also regulatory-affairs certified.

Besides its financial and professional rewards, quality engineering is fun. The problems you confront are often challenging. Typically, you get called in to help solve a problem, but you have no responsibility for implementing the solution. An industrial physicist's job doesn't get any better than that.

For further reading

Pyzdek, T.; Berger, R. W. *Quality Engineering Handbook*; ASQ Quality Press: Milwaukee, 1992.

Bernowski, K. 1997 Salary Survey. *Quality Progress* **1997**, *30* (11), 42.

Juran, J. M.; Gryna, F. M. *Juran's Quality Control Handbook*, 4th ed.; McGraw-Hill: New York, 1988.

American Society for Quality (ASQ) Web site. http://www.asq.org. Ω

BIOGRAPHY

Mark Annett is director of quality for Cerebral Palsy of North Jersey in Livingston, New Jersey (mannett@cpnj.org).