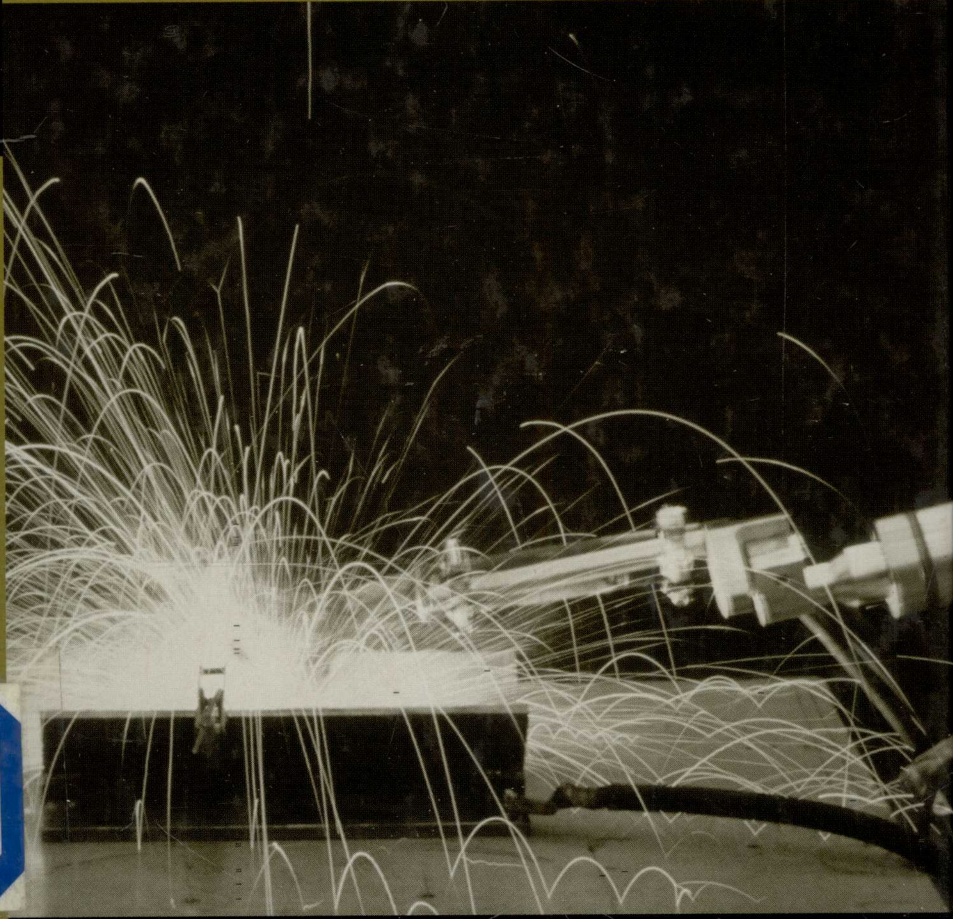
Laser Technology Careers



JAN BONE

VGM Opportunities Series

OPPORTUNITIES IN **LASER TECHNOLOGY CAREERS**

Jan Bone

Revised Edition

Foreword by
Ted Maiman
Inventor of the first laser

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ABOUT THE AUTHOR

Jan Bone has been writing professionally for more than forty years, ever since, as a sixteen-year-old, she had her first newspaper job on the Williamsport, Pennsylvania, *Sun.* Her bachelor's degree is from Cornell University, and she holds an M.B.A. degree from Roosevelt University.

When Ted Maiman successfully invented the first working laser in his laboratory at Hughes Aircraft Corporation, Jan was busy caring for four sons—the oldest in kindergarten. During the three decades that followed, however, her interest in technology has grown significantly.

From 1977 to 1985 Jan served as an elected member of the Board of Trustees of William Rainey Harper College in Palatine, Illinois, and from 1979 to 1985 she was board secretary. During that time, the college set up a CAD/CAM center to train students and professionals in computer-aided design and computer-aided manufacturing, sparking her interest in the field.

She has studied production management and is an associate member of the Society of Manufacturing Engineers and two of its divisions: Computer and Automated Systems Association (CASA) and Robotics International (RI). Because of her interest in lasers and laser technology, she is also a member of SME's Laser Council.

A prolific freelance writer, Jan is senior writer for the *Chicago Tribune*'s special advertising sections and has written special features sections material for the *Chicago Sun-Times* since 1982. She has written for publications as diverse as *Bank Marketing,* *Family Circle, Woman's World, Medical Tribune,* and *National ENQUIRER.* In 1988 she was named contributing editor of *Bank Administration,* the magazine of bank management. Jan is also a part-time writing instructor at Roosevelt University in Chicago.

She is coauthor with Ron Johnson of *Understanding the Film* (NTC/Contemporary Publishing Group, Inc., Lincolnwood, Illinois, 1998, 5th edition) and author of *Opportunities in Film Careers, Opportunities in Cable Television, Opportunities in Telecommunications, Opportunities in Computer-Aided Design and Computer-Aided Manufacturing,* and *Opportunities in Robotics Careers* in the VGM Career Horizons series.

Jan has won the Chicago Working Newsman's Scholarship, the Illinois Education School Bell Award for Best Comprehensive Coverage of Education by dailies under 250,000 circulation, and an American Political Science Award for Distinguished Reporting of Public Affairs. Since 1983, she has been listed in *Who's Who of American Women.*

She is widowed, the mother of four married sons, and the grandmother of four.

FOREWORD

It takes courage to work on something new and different—not to be part of the majority of people who are comfortable doing things in a familiar pattern. When I made the first laser in 1960, I found out firsthand how satisfying it can be to stay with an idea you believe in.

From the public relations standpoint, the press announcement of that laser was extraordinarily successful. The news hit the front page of every major newspaper in the United States and of many papers overseas. Unfortunately, a typical headline read, "Los Angeles Man Discovers Science Fiction Death Ray!"

Shortly thereafter, the owner of Knotts Berry Farm, a popular amusement park, phoned. He wanted to use the laser in a shoot-the-duck game. A representative of the Ice Capades wanted laser light for the spotlights on his performers because of its purity. The president of the American Meat Packers Association wanted to use a laser to stun hogs.

Here were three forward-thinking, progressive, entrepreneurial people who looked on lasers as a tool they could use creatively in their work. Whether it was feasible or not was beside the point. They were ready to try.

Nearly forty years later, the laser is still as exciting and marvelous as it was in its "gee whiz!" days. I'm no longer pulled aside at scientific conferences and asked, "Do you think the laser is ever really going to be useful?" Instead, when someone reads my name badge, they may say, "My grandmother's eyesight was saved because of laser surgery," or even, "Thank you for my job."

The acceptance of lasers came rather slowly, just like that of the airplane and the auto. I seriously doubt that the Wright brothers ever dreamed there would be flights around the world and planes carrying hundreds of passengers. And for many years, automobiles were looked on as a rich man's toy.

I certainly didn't envision lasers becoming part of everyday life... as familiar as the supermarket checkout scanner or the compact audiodisc.

From the beginning, I thought lasers could be used in medicine, but I didn't dream how fantastic today's results would be or the difference they would make in diagnosis and surgery. I felt lasers would be used in communication, but I didn't really see how. It wasn't practical until low-loss fiber was invented ten years later.

Today, lasers in manufacturing improve yield and productivity. You can cut through half an inch of steel with a laser faster than just about any other way.

Today, lasers are used for computer printers and extremely high-density information storage. And tomorrow, tiny lasers inside a computer will achieve much faster speed and performance with optical computing than digital computers now offer.

It's even conceivable that lasers could be the key to solving the energy problem through laser fusion!

To me, lasers are one of the fastest growth industries in the world. There will be jobs in laser technology, not only in working with current laser applications, but also jobs that don't yet exist. The courage of young people—people like yourself who are not afraid to go ahead with ideas they believe in, despite possible discouragement—will make those jobs possible.

Books such as this, which help introduce young people to lasers, play an important role in stimulating imagination and creativity. I hope the laser brings as much satisfaction to your life as it has to mine.

Ted Maiman
Inventor of the first laser

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CHAPTER 1

LASERS: AN INCREDIBLE LIGHT

When laser expert M. J. Soileau visits fourth grade classrooms, he brings a laser with him. The small black box, about eight inches long and one and a half inches wide, intrigues the youngsters, who crowd around him asking what it is. But when Soileau tells them that this simple box is a laser, they don't believe him.

"How come you can't see the beam?" they ask. To them, the word "lasers" conjures up images of the lightsticks used by the Jedi warriors in the *Star Wars* movies, not this ordinary-looking black box.

Soileau, who heads University of Central Florida's CREOL, the Center for Research and Education in Optics and Lasers, is unfazed by their question. He is accustomed to people of all ages not really understanding what lasers are and the many ways that they are used in real life. He explains to the students that light doesn't show up in an unpolluted atmosphere. To see the beam, he explains, all he needs to do is clap two blackboard erasers together, making chalk fly through the air. A light beam aimed through the dust cloud will then be noticeable.

The second question Soileau invariably gets from a grade school class—as well as from most adults!—is, "Don't lasers make holes in things?" He explains that lasers can make holes and are used for precisely that reason in many industrial and medical applications. However, many lasers aren't powerful enough to do anything more than appear bright.

Although most of us don't truly understand lasers and what they can be used for, they nevertheless fascinate and amaze us. When we think of lasers, we imagine powerful bursts of light, intense levels of heat, and very advanced technology. Lasers are all that, and more. Developed just over thirty years ago, lasers have radically changed industry, medicine, and science. Without our even being aware of it, lasers have entered almost every aspect of our daily lives.

THE MANY USES OF LASERS

The most common lasers are used to transmit and store information. When we listen to music on our compact disc player, we are utilizing the power of lasers. The sound is recorded by a laser beam, which burns a pattern of dots onto a compact disc. Then a tiny semiconductor laser in our CD player reads those dots and converts them back into sound. Since only the light from the laser touches the CD, you hear a very clean and clear sound, without the scratches and dust that you would hear on an old vinyl record.

Just as CD players have replaced other methods of recording music, the process of recording information on discs via lasers has revolutionized libraries and other warehouses of information. Lasers are used to create the compact discs that store databases, encyclopedias, art, and all the other kinds of information you regularly access by computer.

And after we have used a CD-ROM disc and found the information we need for a school report, lasers are at work when we print up that report. Laser printers print quickly, creating pages that look as if they were printed professionally. The scanning laser within the printer moves across a light-drum, which attracts ink where the laser has hit it and transfers the ink to the paper as it rolls by.

The scanning laser also is used to read as well as to write. Every time you buy groceries at a supermarket, compact discs at a music store, or clothing at a department store, the scanner reads the labels with the Universal Product Codes' striped patterns and rings up the price.

Or, let's say you wanted to call up some friends and invite them to a laser light show. The fiber-optic cables used by most telephone companies use tiny semiconductor lasers to carry your call across town or around the world. The sound of your voice is converted to electrical pulses and then converted to laser light that can travel through the fiber-optic cables. Using lasers to carry telephone calls is far more efficient than the traditional technology used in telephones, which sent calls over copper wires. Because lasers can pulse very rapidly, one miniscule glass fiber, no wider than a human hair, can actually transmit the calls of more than twenty-thousand old-fashioned copper wires!

Factories use lasers to manufacture an astonishing array of products and materials. Lasers can be powerful enough to cut through more than an inch of a strong metal such as steel, and they can be precise enough to drill two-hundred holes on the head of a pin. Lasers also are used to weld metal, solder tiny circuits for electronics parts, drill miniscule holes, and cut cloth for clothing.

Scientists have discovered that lasers provide a much more accurate way of taking measurements. Using lasers, we now can calculate the distance to the moon much more precisely than ever before. In 1969, astronauts placed an object on the moon that can reflect back a laser beam to its corresponding system on Earth. Lasers are used by the military to guide "smart bombs," transmit messages on the battlefield, and for training to simulate the explosiveness of real ammunition. And just as we have found military uses for lasers, we also are cured by lasers. Doctors in almost every specialty use lasers for a host of procedures, including mending tissue, correcting vision problems, and even erasing lines and wrinkles!

From tiny lasers like the one in a laser pointer to the world's biggest laser, which is housed in a building about the size of an NBA basketball arena at California's Lawrence Livermore National Laboratory, lasers have taken a place in our world. It's hard to imagine that the first working laser was not even invented until 1960. The old saying was that lasers were "a solution in search of a problem." Unlike most inventions, which are created to address a specific need or problem, lasers were developed before there were any practical applications for it. Now lasers are dependable and ubiquitous enough that it is hard to imagine our world without them. And the possibilities for laser use keep growing, as new applications are continuously being developed.

WHAT IS A LASER?

The word *laser* itself is an acronym—*l*ight *a*mplification by *s*timulated *e*mission of *r*adiation. Radiation in this sense is another word for electromagnetic energy, which includes light. A laser is a device that generates or amplifies coherent radiation at frequencies in the infrared, visible, or ultraviolet regions of the electromagnetic spectrum.

Laser light has several properties that make it different from regular light. First, it is often "collimated"—meaning that it travels for long distances in a narrow beam, rather than fragmenting off in many directions as regular light does. Lasers can produce short bursts of light, or they can be used to create a continuous beam. Because it can focus narrowly, the light from a laser can be much more intense than regular light, especially in bursts. The power from a laser beam can be everything from just a few microwatts to several billion watts in short bursts.

Laser light is also coherent. The light waves stay synchronized over long distances. And it is only one color, making it monochromatic. Some laser beams are even invisible, as they produce light in the infrared or ultraviolet wavelengths.

Lasers involve complex terminology and science, and it is natural to be confused by the physics and technology of this intricate invention. Chapter 2 explains how lasers work and tells the story of how Theodore H. Maiman invented the laser in 1960, while he was a research scientist at Hughes Aircraft. Maiman calculates that the whole nine-month project that resulted in the first operating laser cost Hughes no more than $50,000, including his salary, his assistant's salary, and overhead. That is certainly a bargain when you consider that the worldwide market for diode lasers alone reached $2.15 billion in 1998!

In subsequent chapters you will discover the exciting array of opportunities available to people who want to work in the fast-growing field of laser technology. Only a few years ago, lasers were so exotic that they were the exclusive domain of Ph.D.s and other advanced scientists. Now lasers represent a multibillion dollar industry, and we encounter lasers in nearly every aspect of our lives. There are even manuals for building lasers at home! Truly, the opportunities for an exciting career in laser technology are limitless.

THE LASER PATENT WAR

A controversy over patent rights is one of the more fascinating aspects of the early years of the laser. Indeed, this patent "war," which began in 1957 in the physics department at Columbia University, raged for more than thirty years and caused many divisions within the laser world. The battle was over who first had the idea for the laser. Was it Dr. Charles H. Townes, a physics professor at Columbia, and Arther L. Schawlow, his brother-in-law and research partner at Bell Laboratories? Or was it Gordon Gould, who was a thirty-seven-year-old graduate student at Columbia?

In 1987, three decades after the controversy began, Gould won an important legal victory when he was awarded the patent covering gas discharge lasers. Gas discharge lasers are used in roughly 60 percent of all commercial lasers, so this was an important financial victory for Gould as well.

"I conceived the laser in late 1957," Gould remembers, "and I should have applied for a patent right away, but I thought (wrongly, as it turned out) that I had to have a working model first. I left Columbia University, where I was a graduate student, and joined a company where I thought I could get a laser built. Although I applied for a patent in April 1959, by that time there were other inventors applying for patents on various aspects of lasers."

As Gould explains, the U.S. Patent Office has a procedure for deciding who has the right to a patent where claims overlap in applications—a situation the Patent Office calls "interference."

"My application contained many inventions, including two different types of lasers, and it covered various other aspects of lasers. Consequently, there were five interferences with other inventors."

One of those inventors was Charles Townes. In 1951 Townes, continuing experiments first begun in Germany by other researchers, suggested separating a beam of ammonia molecules into two portions. The molecules in each portion of the beam did not have the same energy states; in one portion, the energy state would be higher. Early scientists studying quantum mechanics, a particular branch of physics, had previously believed that if an electromagnetic beam with a particular resonant frequency were passed through a medium, molecules of the beam in a higher state of energy might be stimulated to fall to a lower state of energy—and in the process might reinforce the primary beam.

Townes used a microwave oscillator in his experiments and passed the high-energy portion of his ammonia beam through a cavity that resonated at the frequency that matched the energy difference between the high- and low-energy states. Eventually Townes was awarded a patent for his *maser,* a word coined as an acronym for *m*icrowave *a*mplification by *s*timulated *e*mission of *r*adiation. Masers and lasers are theoretically similar, but masers operate at frequencies in the microwave region of the spectrum, while lasers operate in the light range of the spectrum. Later on, the Townes patent was licensed to laser manufacturers.

Meanwhile, at Bell Laboratories Arthur Schawlow was continuing research on optical masers. Together, Schawlow and Townes proposed a way to get optical maser action. Their plan called for an alkaline vapor to be placed in an optical cavity to serve as an active medium. Such a medium, they thought, could be excited in such a way that if an optical wave were present, it would be amplified as it moved through the medium. According to Gould, Schawlow and Townes didn't realize the active medium could be excited by light.

The work of Townes and Schawlow eventually led to the awarding of another patent in 1960, U.S. Patent Number 2,929,922. Because Schawlow and Townes had applied for a patent before Gould's original application, they were considered the "senior parties."

"I was unable to prove the diligence required to establish a date for my work that was earlier than their patent application," Gould says. "They thought they had won." What the Schawlow and Townes patent claimed to cover, Gould says, was the resonator—the pair of mirrors required to shine the light back and forth through the laser amplifier.

In 1964, Townes won the Nobel prize in physics for developing the laser and maser. And so it seemed that the issue had been settled. Gould, however, had by no means given up his fight to be recognized for his work with lasers and to have his claims recognized