

Precision Instrument and Equipment Repairers

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Significant Points

- Training requirements include a high school diploma and, in some cases, postsecondary education, coupled with significant on-the-job training.
- Good opportunities are expected for most types of jobs.
- Overall employment is expected to grow more slowly than average, but projected growth varies by detailed occupation.
- About 1 out of 5 is self-employed.

Nature of the Work

Repairing and maintaining watches, cameras, musical instruments, medical equipment, and other precision instruments requires a high level of skill and attention to detail. For example, some devices contain tiny gears that must be manufactured to within one one-hundredth of a millimeter of design specifications, and other devices contain sophisticated electronic controls.

Camera and photographic equipment repairers work through a series of steps in fixing a camera. The first step is determining whether a repair should be attempted, because many inexpensive cameras cost more to repair than to replace. Of the problems for which repair seems worthwhile, the most complicated or expensive are referred back to the manufacturer. If the repairers decide to proceed with the job themselves, they diagnose the problem, often by disassembling numerous small parts in order to reach the source. They then make needed adjustments or replace a defective part. Many problems are caused by the electronic circuits used in many cameras, which require an understanding of electronics. Camera repairers also maintain cameras by removing and replacing broken or worn parts and cleaning and lubricating gears and springs. Because many of the components and parts involved are extremely small, repairers must have a great deal of manual dexterity. Frequently, older camera parts are no longer available, requiring repairers to build replacement parts or to strip junked cameras. When machining new parts, workers often use a small lathe, a grinding wheel, and other metalworking tools.

Camera repairers also repair the increasingly popular digital cameras. Repairs on such cameras are similar to those for most modern cameras, but, because digital cameras have no film to wind, they have fewer moving parts.

Watch and clock repairers work almost exclusively on expensive and antique timepieces, as moderately priced timepieces are cheaper to replace than to repair. Electrically powered clocks and quartz watches and clocks function with almost no moving parts, limiting necessary maintenance to replacing the battery. Many expensive timepieces still employ old-style mechanical movements and a manual or automatic winding mechanism. This type of timepiece must be regularly adjusted and maintained. Repair and maintenance work on a mechanical timepiece requires using handtools to disassemble many fine gears and components. Each part is inspected for signs of wear. Some gears or springs may need to be replaced or machined. Exterior portions of the watch may require polishing and buffing. Specialized machines are used to clean all

of the parts with ultrasonic waves and a series of baths in cleaning agents. Reassembling a watch requires lubricating key parts.

As with older cameras, replacement parts are frequently unavailable for antique watches or clocks. In such cases, watch repairers must machine their own parts. They employ small lathes and other machines in creating tiny parts.

Musical instrument repairers and tuners combine their love of music with a highly skilled craft. Musical instrument repairers and tuners, often referred to as technicians, work in four specialties: Band instruments, pianos and organs, violins, and guitars. (Repairers and tuners who work on electronic organs are discussed in the *Handbook* statement on electronic home entertainment equipment installers and repairers.)

Band instrument repairers, brass and wind instrument repairers, and percussion instrument repairers focus on woodwind, brass, reed, and percussion instruments damaged through deterioration or by accident. They move mechanical parts or play scales to find problems. They may unscrew and remove rod pins, keys, worn cork pads, and pistons and remove soldered parts using gas torches. They repair dents in metal and wood using filling techniques or a mallet. These repairers use gas torches, grinding wheels, lathes, shears, mallets, and small handtools and are skilled in metalworking and woodworking. Percussion instrument repairers often must install new drumheads, which are cut from animal skin.

Violin repairers and guitar repairers adjust and repair stringed instruments. Some repairers work on both stringed and band in-



Some musical instrument repairers and tuners specialize in stringed instruments.

struments. Initially, repairers play and inspect the instrument to find any defects. They replace or repair cracked or broken sections and damaged parts. They also restring the instruments and repair damage to their finish.

Piano tuners and repairers use similar techniques, skills, and tools. Most workers in this group are piano tuners, tuning and making minor repairs. Tuning involves tightening and loosening different strings to achieve the proper tone or pitch. Because pianos are difficult to transport, tuners normally make house calls. Some repairers specialize in restoring older pianos. Restoration is complicated work, often involving replacing many of the more than 12,000 parts in some pianos. With proper maintenance and restoration, pianos often survive more than 100 years.

Pipe organ repairers do work similar to that of piano repairers, but on a larger scale. Additionally, they assemble new organs. Because pipe organs are too large to transport, they must be assembled onsite. Even with repairers working in teams or with assistants, the organ assembly process can take several weeks or even months, depending upon the size of the organ.

Medical equipment repairers and *other precision instrument and equipment repairers* maintain, adjust, calibrate, and repair electronic, electromechanical, and hydraulic equipment. They use various tools, including multimeters, specialized software, and computers designed to communicate with specific pieces of hardware. Some of their tools are specialized, such as equipment designed to simulate water or air pressure. These repairers use handtools, soldering irons, and other electronic tools to repair and adjust the equipment. Faulty circuit boards and other parts are normally removed and replaced. Medical equipment and other precision instrument repairers must maintain careful, detailed logs of all maintenance and repair on each piece of equipment.

Medical equipment repairers, often called *biomedical equipment technicians*, work on medical equipment such as defibrillators, heart monitors, medical imaging equipment (x rays, CAT scanners, and ultrasound equipment), and electric wheelchairs.

Other precision instrument and equipment repairers service, repair, and replace a wide range of equipment associated with automated or instrument-controlled manufacturing processes. A precision instrument repairer working at an electric powerplant, for example, would repair and maintain instruments that monitor the operation of the plant, such as pressure and temperature gauges. Replacement parts are not always available, so repairers sometimes machine or fabricate a new part. Preventive maintenance involves regular lubrication, cleaning, and adjustment of many measuring devices.

Working Conditions

Camera, watch, and musical instrument repairers work under fairly similar solitary, low-stress conditions with minimal supervision. A quiet, well-lighted workshop or repair shop is typical, while a few of these repairers travel to the instrument being repaired, such as a piano, organ, or grandfather clock.

Medical equipment and precision instrument and equipment repairers normally work daytime hours, but are often expected to be on call. But, like other hospital and factory employees, some repairers work irregular hours. Precision instrument repairers work under a wide array of conditions, from hot, dirty, noisy factories to air-conditioned workshops to outdoor fieldwork. Attention to safety is essential, as the work sometimes involves dangerous machinery or toxic chemicals. Due to the individual nature of the work, supervision is fairly minimal.

Employment

Precision instrument and equipment repairers held 64,000 jobs in 2002. Medical equipment repairers often work for hospitals or wholesale equipment suppliers, while precision instrument repairers, all other, often work for manufacturing companies and durable goods wholesalers. About 1 out of 5 precision instrument and equipment repairers was self-employed—they may own jewelry, camera, medical equipment, or music stores. The following tabulation presents employment by detailed occupation:

Medical equipment repairers	29,000
Camera and photographic equipment repairers	6,900
Musical instrument repairers and tuners	6,200
Watch repairers	4,800
All other precision instrument and equipment repairers	17,000

Training, Other Qualifications, and Advancement

Most employers require at least a high school diploma for beginning precision instrument and equipment repairers. Many employers prefer applicants with some postsecondary education. Much training takes place on the job. The ability to read and understand technical manuals is important. Necessary physical qualities include good fine motor skills and vision. Also, precision equipment repairers must be able to pay close attention to details, enjoy problem solving, and have the desire to disassemble machines to see how they work. Most precision equipment repairers must be able to work alone with minimal supervision.

The educational background required for camera and photographic equipment repairers varies, but some knowledge of electronics is necessary. Some workers complete postsecondary training, such as an associate degree, in this field. The job requires the ability to read an electronic schematic diagram and comprehend other technical information, in addition to good manual dexterity. New employees are trained on the job in two stages over about a year. First, they assist a senior repairer for about 6 months. Then, they refine their skills by performing repairs on their own for an additional 6 months. Finally, repairers continually hone and improve their skills by attending manufacturer-sponsored seminars on the specifics of particular models.

Training also varies for watch and clock repairers. Several associations, including the American Watchmakers-Clockmakers Institute (AWI) and the National Association of Watch and Clock Collectors, offer certifications. Some certifications can be completed in a few months; some require simply passing an examination; and the most demanding certifications require 3,000 hours, over 2 years, of classroom time in technical institutes or colleges. Clock repairers generally require less training than do watch repairers because watches have smaller components and require greater precision. Some repairers opt to learn through assisting a master watch repairer. Nevertheless, developing proficiency in watch or clock repair requires several years of education and experience.

For musical instrument repairers and tuners, employers prefer people with post-high school training in music repair technology. According to a Piano Technicians Guild membership survey, the overwhelming majority of respondents had completed at least some college work; most had a bachelor's or higher degree, although not always in music repair technology. Almost all repairers have a strong musical background. A basic ability to play the instruments being repaired is helpful, but not always required. A few technical schools and colleges offer courses in instrument repair, and correspondence courses also are common. Graduates of these programs normally receive additional training on the job, working with an experienced repairer. A few musical instrument repairers and tuners begin learning their trade on the job as assistants or apprentices. Trainees per-

form a variety of tasks around the shop. Full qualification usually requires 2 to 5 years of training and practice.

Medical equipment repairers are trained in a similar manner. An associate degree in electronics or medical technology is helpful, but not always required. The required training varies by specialty. On-the-job training, for those with a background in electronics, is more common for workers repairing less critical equipment such as hospital beds or electric wheelchairs. An associate or even a bachelor's degree, often in medical technology or engineering, and a passing grade on a certification exam is likely to be required of persons repairing more critical equipment such as CAT scanners and defibrillators. Some repairers are trained in the military. New repairers begin by observing and assisting an experienced worker over a period of 3 to 6 months. Gradually, they begin working independently, while still under close supervision.

Educational requirements for other precision instrument and equipment repair jobs also vary, but include a high school diploma, with a focus on mathematics and science courses. Most employers require an associate or sometimes a bachelor's degree in instrumentation and control, electronics, or a related engineering field, as repairers need to understand blueprints, electrical schematic diagrams, and electrical, hydraulic, and electromechanical systems. In addition to formal education, a year or two of on-the-job training is required before a repairer is considered fully qualified. Some advancement opportunities exist, but many supervisory positions require a bachelor's degree.

Job Outlook

Good opportunities are expected for most types of precision instrument and equipment repairer jobs. Overall employment growth is projected to be slower than the average for all occupations over the 2002-12 period. However, projected growth varies by detailed occupation.

Job growth among medical equipment repairers should be about as fast as the average for all occupations over the projected period. The rapidly expanding healthcare industry and elderly population should spark demand for increasingly sophisticated medical equipment and, in turn, create good employment opportunities in this occupation.

On the other hand, employment of musical instrument repairers is expected to increase more slowly than the average. Replacement needs will provide the most job opportunities as many repairers and tuners are expected to retire. While an increase in the number of school-age children involved with music should spur demand for repairers, music must compete with other extracurricular activities and interests. Without new musicians, there will be a slump in instrument rentals, purchases, and repairs. Because training in the repair of musical instruments is difficult to obtain—there are only a few schools that offer training programs, and few experienced workers are willing to take on apprentices—opportunities should be good for those who receive training.

Employment of camera and photographic equipment repairers is expected to decline. The popularity of inexpensive cameras adversely affects employment in this occupation, as most point-and-shoot cameras are cheaper to replace than repair. The rapid technological progress in digital cameras also has hurt the job prospects of repairers. When a digital camera breaks, not only is replacing the camera often not much more expensive, but the new model is also far more advanced.

Employment of watch repairers is expected to increase more slowly than the average. Over the past few decades, changes in technology, including the invention of digital and quartz watches that need few repairs, caused a significant decline in the demand for

watch repairers. In recent years, this trend was somewhat reversed, as the growing popularity of expensive mechanical watches increased the need for watch repairers. While the demand for watch repairers has risen, however, few new repairers have entered the field. The small number of entrants, coupled with the fact that a large proportion of watch and clock repairers are approaching retirement age, should result in very good job opportunities in this field.

The projected slower-than-average employment growth of other precision instrument and equipment repairers reflects the expected lack of employment growth in manufacturing and other industries in which they are employed. Nevertheless, good employment opportunities are expected for these precision instrument and equipment repairers due to the relatively small number of people entering the occupation and the need to replace repairers who retire.

Earnings

The following tabulation shows median hourly earnings for various precision instrument and equipment repairers in 2002. Earnings ranged from less than \$7.59 for the lowest 10 percent of watch repairers, to more than \$30.68 for the highest 10 percent of precision instrument and equipment repairers, all other. Median hourly earnings of all precision instrument and equipment repairers by occupation are:

Precision instrument and equipment repairers, all other	\$21.20
Medical equipment repairers	17.49
Camera and photographic equipment repairers	15.09
Musical instrument repairers and tuners	14.15
Watch repairers	12.77

Earnings within the different occupations vary significantly, depending upon skill levels. For example, a watch and clock repairer may simply change batteries and replace worn wrist straps, while highly skilled watch and clock repairers, with years of training and experience, may rebuild and replace worn parts. According to a survey by the American Watchmakers-Clockmakers Institute, the median annual earnings of highly skilled watch and clock repairers were about \$42,500 in 2001.

Related Occupations

Many precision instrument and equipment repairers work with precision mechanical and electronic equipment. Other workers who repair precision mechanical and electronic equipment include computer, automated teller, and office machine repairers and coin, vending, and amusement machine servicers and repairers. Other workers who make precision items include dental laboratory technicians and ophthalmic laboratory technicians. Some precision instrument and equipment repairers work with a wide array of industrial equipment. Their work environment and responsibilities are similar to those of industrial machinery installation, maintenance, and repair workers. Much of the work of watch repairers is similar to that of jewelers and precious stone and metal workers. Camera repairers' work is similar to that of electronic home entertainment equipment installers and repairers; both occupations work with consumer electronics that are based around a circuit board, but that also involve numerous moving mechanical parts.

Sources of Additional Information

For more information about camera repair careers, contact:

► National Association of Photographic Equipment Technicians (NAPET), 3000 Picture Pl., Jackson, MI 49201.

For information on musical instrument repair, including schools offering training, contact:

► National Association of Professional Band Instrument Repair Technicians (NAPBIRT), P.O. Box 51, Normal, IL 61761. Internet: <http://www.napbirt.org>

For additional information on piano tuning and repairwork, contact:

► Piano Technicians Guild, 3930 Washington St., Kansas City, MO 64111-2963. Internet: <http://www.ptg.org>

For information about training, mentoring programs, employers, and schools with programs in precision instrumentation, automation, and control, contact:

► ISA-The Instrumentation, Systems, and Automation Society, 67 Alexander Dr., P.O. Box 12277, Research Triangle Park, NC 27709. Internet: <http://www.isa.org>

For information about watch and clock repair and a list of schools with related programs of study, contact:

► American Watchmakers-Clockmakers Institute (AWI), 701 Enterprise Dr., Harrison, OH 45030-1696. Internet: <http://www.awi-net.org>

For information about medical equipment technicians and a list of schools with related programs of study, contact:

► Association for the Advancement of Medical Instrumentation (AAMI), 1110 North Glebe Rd., Arlington, VA 22201-4795. Internet: <http://www.aami.org>