Computer Control Programmers and Operators

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Significant Points

- Manufacturing industries employ almost all of these workers.

- Workers learn in apprenticeship programs, informally on the job, and in secondary, vocational, or post-secondary schools; many entrants have previously worked as machinists or machine setters, operators, and tenders.

- Despite the projected slow decline in employment, job opportunities should be excellent, as employers are expected to continue to have difficulty finding qualified workers.

Nature of the Work

Computer control programmers and operators use computer numerically controlled (CNC) machines to cut and shape precision products, such as automobile, aviation, and machine parts. CNC machines operate by reading the code included in a computer-controlled module, which drives the machine tool and performs the functions of forming and shaping a part formerly done by machine operators. CNC machines include machining tools such as lathes, multi-axis spindles, milling machines, laser cutting machines, and wire electrical discharge machines. CNC machines cut away material from a solid block of metal or plastic—known as a workpiece—to form a finished part. Computer control programmers and operators normally produce large quantities of one part, although they may produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with CNC programming to design and carry out the operations needed to make machined products that meet precise specifications.

CNC programmers—also referred to as *numerical tool and process control programmers*—develop the programs that run the machine tools. They review three-dimensional computer aided/automated design (CAD) blueprints of the part and determine the sequence of events that will be needed to make the part. This may involve calculating where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove.

Next, CNC programmers turn the planned machining operations into a set of instructions. These instructions are translated into a computer aided/automated manufacturing (CAM) program containing a set of commands for the machine to follow. These commands normally are a series of numbers (hence, numerical control) that describes where cuts should occur, what type of cut should be used, and the speed of the cut. After the program is developed, CNC programmers and operators check the programs to ensure that the machinery will function properly and that the output will meet specifications. Because a problem with the program could damage costly machinery and cutting tools or simply waste valuable time and materials, computer simulations may be used to check the program before a trial run. If errors are found, the program must be changed and retested until the problem is resolved. In addition, growing connectivity between CAD/CAM software and CNC machine tools is raising productivity by automatically translating designs into instructions for the computer controller on the machine tool. These new CAM technologies enable programs to be easily modified for use on other jobs with similar specifications.

After the programming work is completed, *CNC setup operators*—also referred to as computer-controlled machine tool operators, metal and plastic—set up the machine for the job. They download the program into the machine, load the proper cutting tools into the tool holder, position the workpiece (piece of metal or plastic that is being shaped) on the CNC machine tool—spindle, lathe, milling machine, or other machine—and then start the machine. During the test run of a new program, the setup operator, who may also have some programming skills, or the CNC programmer closely monitors the machine for signs of problems, such as a vibrating work piece, the breakage of cutting tools, or an out-of-specification final product. If a problem is detected, a setup operator or CNC programmer will modify the program using the control module to eliminate the problems or to improve the speed and accuracy of the program.

Once a program is completed, the operation of the CNC machine may move from the more experienced setup operator to a less-skilled machine operator. Operators load workpieces and cutting tools into a machine, press the start button, monitor the machine for problems, and measure the parts produced to check that they match specifications. If they encounter a problem that requires modification to the cutting program, they shut down the machine and wait for a more experienced CNC setup operator to fix the problem. Many CNC operators start at this basic level and gradually perform more setup tasks as they gain experience.

Regardless of skill level, all CNC operators detect some problems by listening for specific sounds—for example, a dull cutting tool that needs changing or excessive vibration. Machine tools rotate at high speeds, which can create problems with harmonic vibrations in the workpiece. Vibrations cause the machine tools to make minor cutting errors, hurting the quality of the product. Operators listen for vibrations and

Computer control operators reprogram computer numerically controlled machines.

then adjust the cutting speed to compensate. CNC operators also ensure that the workpiece is being properly lubricated and cooled, because the machining of metal products generates a significant amount of heat.

Since CNC machines can operate with limited input from the operator, a single operator may monitor several machines simultaneously. Typically, an operator might monitor two machines cutting relatively simple parts from softer materials, while devoting most of his or her attention to a third machine cutting a much more difficult part from hard metal, such as stainless steel. Operators are often expected to carefully schedule their work so that all of the machines are always operating.

Work environment. Most machine shops are clean, well lit, and ventilated. Most modern CNC machines are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. Nevertheless, working around machine tools can be noisy and presents certain dangers, and workers must follow safety precautions. Computer-controlled machine tool operators, metal and plastic, wear protective equipment, such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants. The job requires stamina because operators stand most of the day and, at times, may need to lift moderately heavy workpieces.

Numerical tool and process control programmers work on desktop computers in offices that typically are near, but separate from, the shop floor. These work areas usually are clean, well lit, and free of machine noise. Numerical tool and process control programmers occasionally need to enter the shop floor to monitor CNC machining operations. On the shop floor, CNC programmers encounter the same hazards and exercise the same safety precautions as do CNC operators.

Many computer control programmers and operators work a 40-hour week. CNC operators increasingly work evening and weekend shifts as companies justify investments in more expensive machinery by extending hours of operation. Overtime is common during peak production periods.

Training, Other Qualifications, and Advancement

Computer control programmers and operators train in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. In general, the more skills needed for the job, the more education and training are needed to qualify. Many entrants have previously worked as machinists or machine setters, operators, and tenders.

Education and training. The amount and type of education and training needed depends on the type of job. Entry-level CNC machine operators may need only a couple of weeks of on-the-job training to reach proficiency. Setup operators and programmers, however, may need years of experience or formal training to write or modify programs. Programmers and operators can receive their training in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. A growing number

of computer control programmers and more skilled operators receive their formal training from community or technical colleges. For some specialized types of programming, such as that needed to produce complex parts for the aerospace or shipbuilding industries, employers may prefer individuals with a degree in engineering.

For those interested in becoming computer control programmers or operators, high school or vocational school courses in mathematics (trigonometry and algebra), blueprint reading, computer programming, metalworking, and drafting are recommended. Apprenticeship programs consist of shop training and related classroom instruction. In shop training, apprentices learn filing, handtapping, and dowel fitting, as well as the operation of various machine tools. Classroom instruction includes math, physics, programming, blueprint reading, CAD software, safety, and shop practices. Skilled computer control programmers and operators need an understanding of the machining process, including the complex physics that occur at the cutting point. Thus, most training programs teach CNC operators and programmers to perform operations on manual machines prior to operating CNC machines.

As new automation is introduced, computer control programmers and operators normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Many employers offer tuition reimbursement for job-related courses.

Certification and other qualifications. Employers prefer to hire workers who have a basic knowledge of computers and electronics and experience with machine tools. In fact, many entrants to these occupations have previously worked as machinists or machine setters, operators, and tenders. Persons interested in becoming computer control programmers or operators should be mechanically inclined and able to work independently and do highly accurate work.

To boost the skill level of all metalworkers and to create a more uniform standard of competency, a number of training facilities and colleges have recently begun implementing curriculums by incorporating national skills standards developed by the National Institute of Metalworking Skills (NIMS). After completing such a curriculum and passing a performance requirement and written exam, trainees are granted an NIMS credential that provides formal recognition of competency in a metalworking field. Completion of a formal certification program provides expanded career opportunities.

Advancement. Computer control programmers and operators can advance in several ways. Experienced CNC operators may become CNC programmers, and some are promoted to supervisory or administrative positions in their firms. A few open their own shops.

Employment

Computer control programmers and operators held about 158,000 jobs in 2006. About 89 percent were computer-controlled machine tool operators, metal and plastic, and about 11 percent were numerical tool and process control programmers. Manufacturing employs almost all of these workers. Employment was concentrated in fabricated metal products

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Computer control programmers and operators	51-4010	158,000	153,000	-5,700	-4
Computer-controlled machine tool operators, metal and plastic ..	51-4011	141,000	136,000	-4,200	-3
Numerical tool and process control programmers........................	51-4012	18,000	16,000	-1,500	-8

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

manufacturing, machinery manufacturing, plastics products manufacturing, and transportation equipment manufacturing making mostly aerospace and automobile parts. Although computer control programmers and operators work in all parts of the country, jobs are most plentiful in the areas where manufacturing is concentrated.

Job Outlook

Despite the projected slow decline in employment of computer control programmers and operators, job opportunities should be excellent, as employers are expected to continue to have difficulty finding qualified workers.

Employment change. Employment of computer control programmers and operators is expected to decline slowly by 4 percent through 2016. While CNC machine tools will be increasingly used, advances in CNC machine tools and manufacturing technology will further automate the production process, boosting CNC operator productivity and limiting employment. The demand for computer control programmers also will be negatively affected by the increasing use of software (CAD/CAM) that automatically translates part and product designs into CNC machine tool instructions.

Job prospects. Computer control programmers and operators should have excellent job opportunities despite the projected slow decline in employment. Due to the limited number of people entering training programs, employers are expected to continue to have difficulty finding workers with the necessary skills and knowledge.

Earnings

Median hourly earnings of computer-controlled machine tool operators, metal and plastic, were $15.23 in May 2006. The middle 50 percent earned between $12.10 and $18.84. The lowest 10 percent earned less than $9.91, whereas the top 10 percent earned more than $22.45. Median hourly earnings in the manufacturing industries employing the largest numbers of computer-controlled machine tool operators, metal and plastic, in May 2006 were:

Metalworking machinery manufacturing	$17.45
Other fabricated metal product manufacturing	15.34
Machine shops; turned product; and screw, nut, and bolt manufacturing	14.85
Motor vehicle parts manufacturing	14.12
Plastics product manufacturing	12.32

Median hourly earnings of numerical tool and process control programmers were $20.42 in May 2006. The middle 50 percent earned between $16.14 and $25.61. The lowest 10 percent earned less than $13.11, while the top 10 percent earned more than $31.85.

Many employers, especially those with formal apprenticeship programs, offer tuition assistance for training classes.

Related Occupations

Occupations most closely related to computer control programmers and operators are other metal and plastic working occupations, which include machinists; tool and die makers; machine setters, operators, and tenders—metal and plastic; and welding, soldering, and brazing workers. Numerical tool and process control programmers apply their knowledge of machining operations, metals, blueprints, and machine programming to write programs that run machine tools. Computer programmers also write detailed programs to meet precise specifications.

Sources of Additional Information

For general information about computer control programmers and operators, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141-3292.
Internet: **http://www.pmpa.org/industry-careers/**

For a list of training centers and apprenticeship programs, contact:

➤ National Tooling and Metalworking Association, 9300 Livingston Rd., Fort Washington, MD 20744.

For more information on credential standards and apprenticeship, contact:

➤ The National Institute for Metalworking Skills, 10565 Fairfax Blvd., Suite 203, Fairfax, VA 22030.
Internet: **http://www.nims-skills.org/home/index.htm**