



PLTW Engineering

**12/Career Exploration – Materials
Engineer**

May 15, 2020



12/EDD

Lesson: 5/15/2020

Objective/Learning Target: Students will be able to explain the career path of a machinist or tool and die maker.



What do machinists do?

Machinists use machine tools, such as lathes, milling machines, and grinders, to produce precision metal parts.

Many machinists must be able to use both manual and CNC machinery. CNC machines control the cutting tool speed and do all necessary cuts to create a part.

The machinist determines the cutting path, the speed of the cut, and the feed rate by programming instructions into the CNC machine.



What do machinists do?

Although workers may produce large quantities of one part, precision machinists often produce small batches or one-of-a-kind items.

The parts that machinists make range from simple steel bolts to titanium bone screws for orthopedic implants.

Hydraulic parts, antilock brakes, and automobile pistons are other widely known products that machinists make.



What type of machines are used?

Some manufacturing processes use lasers, water jets, and electrified wires to cut the workpiece. As engineers design and build new types of machine tools, machinists must learn new machining properties and techniques.



What do tool and die makers do?

Tool and die makers construct precision tools or metal forms, called dies, that are used to cut, shape, and form metal and other materials.

They produce jigs and fixtures—devices that hold metal while it is bored, stamped, or drilled—and gauges and other measuring devices.



What do tool and die makers do?

Tool and die makers use CAD to develop products and parts. They enter designs into computer programs that produce blueprints for the required tools and dies.

Computer numeric control programmers, CNC programmers, convert CAD designs into CAM programs that contain instructions for a sequence of cutting-tool operations.



What do tool and die makers do?

Once these programs are developed, CNC machines follow the set of instructions contained in the program to produce the part.

Machinists normally operate CNC machines, but tool and die makers often are trained to both operate CNC machines and write CNC programs and thus may do either task.



Typical duties of a machinist

- Read blueprints, sketches, or computer-aided design (CAD) and computer-aided manufacturing (CAM) files
- Set up, operate, and disassemble manual, automatic, and computer numerically controlled (CNC) machine tools
- Align, secure, and adjust cutting tools and workpieces
- Monitor the feed and speed of machines
- Turn, mill, drill, shape, and grind machine parts to specifications
- Measure, examine, and test completed products for defects
- Smooth the surfaces of parts or products
- Present finished workpieces to customers and make modifications if needed



Typical duties of a tool and die maker

- Read blueprints, sketches, specifications, or CAD and CAM files for making tools and dies
- Compute and verify dimensions, sizes, shapes, and tolerances of workpieces
- Set up, operate, and disassemble conventional, manual, and CNC machine tools
- File, grind, and adjust parts so that they fit together properly
- Test completed tools and dies to ensure that they meet specifications
- Smooth and polish the surfaces of tools and dies



Work environment and work schedules

Because machinists and tool and die makers work around machine tools that may present hazards, these workers must follow precautions to avoid injuries.

For example, workers must wear protective equipment, such as safety glasses, to shield against bits of flying metal, earplugs to dampen the noise produced by machinery, and masks to limit their exposure to fumes.

Some work evenings and weekends because facilities may operate around the clock.



How to become a machinist or tool and die maker

Machinists and tool and die makers typically are trained on the job.

Some learn through training or apprenticeship programs, vocational schools, or community and technical colleges.

Although machinists typically need just a high school diploma, tool and die makers may need to complete courses beyond high school.



Education requirements

Machinists typically have a high school diploma or equivalent, whereas tool and die makers may need to complete courses beyond high school.

High school courses in math, blueprint reading, metalworking, and drafting are considered useful.

Some community colleges and technical schools have 2-year programs that train students to become machinists or tool and die makers.



Education requirements

These programs usually teach design and blueprint reading, the use of a variety of welding and cutting tools, and the programming and function of computer numerically controlled (CNC) machines.



Specialized training

There are multiple ways for workers to gain competency in the job as a machinist or tool or die maker.

One common way is through long-term on-the-job training, which lasts 1 year or longer.

Trainees usually work 40 hours per week and take additional technical instruction during evenings. Trainees often begin as machine operators and gradually take on more difficult assignments.



Specialized training

Machinists and tool and die makers must be experienced in using computers to work with CAD/CAM technology, CNC machine tools, and computerized measuring machines.

Some machinists become tool and die makers.

Some new workers may enter apprenticeship programs, which are typically sponsored by a manufacturer.



Specialized training

Apprenticeship programs often consist of paid shop training and related technical instruction lasting several years.

The technical instruction usually is provided in cooperation with local community colleges and vocational-technical schools.

Workers typically enter into apprenticeships with a high school diploma or equivalent.



Important qualities for these trades

Analytical skill

Machinists and tool and die makers must understand technical blueprints, models, and specifications so that they can craft precision tools and metal parts.

Manual dexterity

Machinists' and tool and die makers' work must be accurate. For example, machining parts may demand accuracy to within .0001 of an inch, a level of accuracy that requires workers' concentration and dexterity.



Important qualities for these trades

Math skills and computer application experience

Workers must be experienced in using computers to work with CAD/CAM technology, CNC machine tools, and computerized measuring machines.

Mechanical skills

Machinists and tool and die makers must operate milling machines, lathes, grinders, laser and water cutting machines, wire electrical discharge machines, and other machine tools.



Important qualities for these trades

Physical stamina

Machinist and tool and die makers must stand for extended periods and perform repetitious movements.

Technical skills

Machinists and tool and die makers must understand computerized measuring machines and metalworking processes, such as stock removal, chip control, and heat treating and plating.



How much to these occupations get paid?

The median annual wage for machinists was \$44,420 in May 2019. The median wage is the wage at which half the workers in an occupation earned more than that amount and half earned less. The lowest 10 percent earned less than \$27,940, and the highest 10 percent earned more than \$66,610.

The median annual wage for tool and die makers was \$53,920 in May 2019. The lowest 10 percent earned less than \$33,820, and the highest 10 percent earned more than \$77,940.



Quiz yourself

1. List 3 different machine tools
2. What does CNC stand for?
3. List 2 types of parts made with machine tools.
4. List 1 typical duty of a machinist and one of a tool and die maker.
5. What is the minimum education for a tool and die maker?



Helpful links

[Machinist job outlook including salaries](#)

[Explanation of Tool and Die making as a career](#)