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A Hand Book
on
eMachineShop.com

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Application Note: CNC Milling

Computer Numerical Control (CNC) machines perform functions of drilling, milling, turning, etc. CNC Mills are usually defined in terms of the number of axes they handle. Axes are generally labeled as x and y for horizontal movement and z for vertical movement. The number of axes of a milling machine is significant. A standard manual industrial mill typically has four axes:

- Table x.
- Table y.
- Table z.
- Milling Head z.

A five-axis CNC milling machine has an extra axis. This axis is the basis of a horizontal pivot for the milling head. This allows a greater flexibility for machining with the end mill at an angle with respect to the table. A six-axis CNC milling machine has another horizontal pivot for the milling head, perpendicular to the fifth axis.

Material is usually removed by both the end and the side of the cutting tool. In **CNC milling** the cutting tool usually rotates about an axis that is perpendicular to the table, which holds the material to be cut. Cutting tools of various profile shapes include: square, rounded, and angled. A wide variety of part shapes and geometries are possible by a CNC machine. Interestingly, CNC machines come in various models, which range from small desk-top lathes and milling machines to larger full-sized machining centers.

CNC machines used by www.eMachineShop.com are traditionally programmed using a set of commands known as G-codes. G-codes represent specific CNC functions in alpha-numeric format. **CNC milling** machines carry out the cutting process in which materials are removed from a block by a rotating tool. In CNC milling, the cutting tool is moved in all three dimensions to achieve the desired cut shape.

Online CNC machining ensures optimal work-related selection of manufacturing systems and the configuration to satisfy the range of parts to be processed.

A key advantage of **CNC machining** is the wide variety of work piece features that it can produce. Part features such as walls, pockets of different depths, tapped holes, bolt-hole circle patterns and others commonly found on prototypes can be precisely produced on a **CNC machine**. One other advantage of CNC machines is their ability to produce metal molds which can then be used for injection molding operations.

Application Note: Rapid Prototyping Machine

Rapid prototyping is the automatic and quick-turn construction of physical objects. This type of prototyping has been developed as an outgrowth of liquid photopolymer research. Early rapid prototyping (RP) used machines called SLA's (Stereo Lithography Apparatus). More recently, another approach called FDM (Fused Deposition Modeling) makes use of a heated nozzle to extrude plastic onto the work piece. Fused Deposition Modeling led to the use of a wider range of materials including polycarbonates, ABS and other plastics. Fused plastic is deposited layer by layer according to the 3D model. Numerous shapes are possible with a rapid prototyping machine.

A **rapid prototyping** machine takes virtual designs from computer aided design (CAD) software, transforms them into cross sections and later creates each cross-section in sequence, one after the next until the model is completely finished. It is a WYSIWYG ("what you see is what you get") process where the virtual model and the physical model align. The rapid prototyping machine reads data from a CAD drawing and lays down successive layers of liquid or powdered material, creating the model from a series of cross sections. These layers, derived from the CAD model, are fused together automatically to create the final shape. The primary advantage to additive construction is its ability to create almost any geometry and patterns.

www.eMachineShop.com advises designers to observe an important design constraint in **rapid prototype** design - since the FDM extrusion is generally .010" wide, it is best to keep dimensions in multiples of this value - especially smaller dimensions (including material, air, diameters, etc.).

With the advent of **rapid prototyping machines** it is now possible for eMachineShop CAD software to output directly to a rapid prototyping machine. Importantly, eMachineShop keeps the run costs low since rapid prototyping does not require tooling; short production runs can be made at lower cost and faster turnaround. This approach also provides higher confidence when committing to conventional tooling. Rapid prototyping helps engineers, designers and end users check designs for usability, appearance and manufacturability. **Rapid prototype machines** help to speed up the new product design cycle.

Application Note: Metal Fabrication

The process of manufacturing metal components is generally called metal fabrication. Metal fabrication processes may be classified as cold, warm, and hot working depending on the temperature at which the material is processed. At eMachineShop, many things are transformed by **metal fabrication** processes, such as bending, milling, cutting, punching, drilling, turning, grinding and threading. Metal parts made range from small parts the size of paper clips and even smaller using photochemical milling, to large industrial parts constructed using large **CNC milling** and turning machines.

eMachineShop uses a wide range of metal fabricating machinery and machining processes online to meet virtually all client metal fabrication needs. **Metal fabrication** can be broadly divided into forming, removal and non-conventional, which is further sub divided into several categories.

- **Forging:** Forging involves forming work pieces by compressive force at high heat. Parts such as crankshafts, connecting rods, gears and bolt heads can be made by forging.
- **Rolling:** Rolling is a process of reducing the thickness of a long work piece by compressive forces using a set of rolls. Plates used for Machine structures, vessels and sheets used for automobile and aircraft bodies, appliances and furniture are created by rolling. Rolled stock is often cut using water jet or laser cutters.
- **Extrusion:** During extrusion round billets are forced through one or more dies by a compressive force that is applied to a ram. The extruded piece that emerges has the desired shape. In general, extrusion is used to produce cylindrical bars or hollow tubes, but shapes of irregular cross sections may be produced from the more readily extrudable metals, such as Aluminum.
- **Drawing:** Drawing is the pulling of a metal piece through a die having a tapered bore by means of a tensile force that is applied on the exit side. Rod, wire and tubing products are commonly fabricated by drawing.

There are several methods of metal removing such as metal cutting, abrasive processes and non-conventional metal removing processes. Sawing, for instance, is a type of cutting in which the cutting tool is a blade that has a series of small teeth, with each tooth removing a small amount of material. Shearing on the other hand is a metal cutting process through which flat surfaces and various cross-sections with grooves and notches are produced.

Face milling and end milling are some of the types of cutting used. Grinding – on the other hand -- is a chip removal process in which the cutting tool is an abrasive grain wheel. The different types of grinding processes are surface grinding, cylindrical grinding, internal grinding and centerless grinding. For extremely thin material, photochemical milling may be used. In this process, a caustic chemical etches away undesired material.

Free CAD Software Download

The free CAD software from www.eMachineShop.com is intelligent software that allows you to create your own design and also check whether the design can be machined -- all at the click of your mouse. The software has been designed to be easily used by beginners and powerful enough for professional engineers. Informative prompts and 3D views of parts being designed contribute to ease of use. To get started designing parts and having them built by eMachineShop, all you need to do is download the **free CAD software** from eMachineShop. The software begins as a **3D CAD program** but also incorporates an automated machinist expert to advise you on fine points of design, instant pricing for a wide range of materials and processes and order processing with order tracking.

While most CAD packages are designed to create general geometric shapes without regard for manufacturability, price, or setting up real jobs for ordering, the eMachineShop **free CAD software** was designed from the ground up to serve all these functions in a seamless yet-powerful package. The price quotation portion of the software download allows you to select the best price and order delivery option for your requirements. Even the shipping cost is automatically calculated by the software.

eMachineShop does not review designs for applicability to a given design problem, but encourages customers to download the easy-to-use software and determine for themselves whether eMachineShop can meet their needs. A one-off part for a new invention may be less tightly engineered than a comparatively more exotic aerospace part in a mission critical application.

At www.eMachineShop.com simple jobs on simple machines generally start at around \$150 for setup and as low as \$1 per part (or even lower) for simple parts run in quantity. eMachineShop is competitive on most types of parts - in small or large quantity.

With eMachineShop a single command in the software gives you a price instantly. There is no time wasted in gathering price quotations. Potential customers of eMachineShop simply draw or import the design and receive their instant price quote.

Investing just a few minutes to download the software will allow you to discover an exciting new tool which can be used in many ways. Inventors, professional product designers, engineers, and even hobbyists agree on this point. The **free CAD software** allows for ordering by all major credit cards, check or money order. Assistance is always just a click away.

Application Note: CNC Machine Shop Processes

People new to product and part design need to know that CNC means 'computer numerical control'. It generally means a computer controller for a cutting machine such as a lathe, milling machine, water jet (waterjet) cutter, or laser cutter, that reads G-code instructions and steers the machine cutting head - a powered mechanical device, typically used to fabricate metal components by the selective removal of metal.

The most important benefit offered by a **CNC machine** is improved automation of part manufacturing. The operator intervention related to producing work pieces can be reduced or, on some machines, altogether eliminated. A second important benefit of CNC technology is consistent and accurate work pieces. This means that once a program has been verified, two, ten, or one thousand identical work pieces can be easily produced with great precision and consistency.

Another reason why CNC machining shops have become popular is flexibility. Since these machines are run from computer programs, running a different work piece is almost as easy as loading a different program and different target material. Once a program has been verified and executed for one production run, it can be easily recalled the next time when the work piece is to be run. This leads to yet another important benefit, fast change-overs. Since these machines are easy to setup and run, and since programs can be easily loaded, they allow short setup time.

Various tools making use of CNC variants are:

Drills

EDM's

Lathes

Milling machines

Wood routers

Sheet metal works

Hot-wire foam cutters

Plasma cuttings

Water jet cutters

Laser cutting

Oxy-fuel

At www.eMachineShop.com, the online **CNC machine shop** makes a wide variety of 2D and 3D shapes. CNC milling may be used to create engine components, custom and mold tooling, complex mechanisms, enclosures, etc. One advantage of **CNC milling** at eMachineShop is the cost effectiveness for short runs, with complex shapes cut from sheet, block or bar stock material.

As you design parts, eMachineShop suggests you use the free eMachineShop software to try various combinations of machines and processes, along with alternate material choices to optimize your designs.

CNC machining involves a material that is usually removed by both the ends and the side of the cutting tool. In CNC milling the cutting tool usually rotates about an axis that is perpendicular to the table that holds the material to be cut. Cutting tools of various profile shapes are available including square, rounded, and angled. A wide variety of part shapes and geometries are possible in this fashion.

Keep in mind that CNC is not a total “computer solution.” You should be aware that CNC milling requires not only software program tooling but in many cases work-holding jigs. This is why machine and material optimization – easily done within eMachineShop’s **free CAD software** – is so important to achieving the best possible price/performance result.

Application Note: Latest Laser Cutting Technology

Modern laser cutting machines are important to new product designers because they can accurately produce complex shapes. A laser beam is typically just thousandths of an inch in diameter at the cutting surface with a highly focused power of up to 2000 watts. *CNC laser cutting* takes direct input electronic data from a computer aided design (CAD) drawings to produce precise flat form parts of any complexity.

Lasers usually work best on materials such as carbon steel or stainless steels. Metals such as aluminum and copper alloys are more difficult to cut because they can reflect the laser's light as well as absorb and conduct heat away from the cut. To laser cut these materials, a higher power laser is required. The range of materials that can be cut by **laser cutting** includes stainless steel, carbon steel, aluminum, galvanized steel, polyethylene, acrylic, Delrin [an acetal resin product], nylon, wood and even MDF and plywood.

The first machine shop designed for the Internet, eMachineShop, offers CNC laser cutting online. www.eMachineShop.com makes use of the latest laser cutting technology for a fine, clean, accurate depth of cut. The fine cuts are achieved through software-controlled adjustment of both the laser's cutting speed and power output.

The **Laser Cutting** machine produces part shapes by cutting sheet material using an intense laser beam. During laser cutting, a beam of high-density light energy is focused through a tiny nozzle/lens. When the resulting beam strikes the surface of the work piece, the material of the work piece is vaporized.

CNC **Laser** cutting is popular for a wide range of cutting requirements – from simple to intricate - designs are faithfully produced to the CNC file settings. Example applications include aerospace, architectural, automotive, biomedical, decorative, electronic, medical, petrochemical, and power generation.

CNC **Laser** Cutting offered by eMachineShop keeps costs low since no physical tooling is required. Heat distortion is minimal (the heat affected zone is about 10% of material thickness). As a result parts remain flat. The laser machine produces identical parts consistently, maintains close tolerances, over a wide range of materials and with minimal burrs.

eMachineShop endeavors to provide easy, convenient and low-cost fabrication of custom parts via the Internet. This is done by fully leveraging the web, software, and state-of-the-art CNC **laser metal cutting** and machining technologies.

Concept: The Online Machine Shop

www.eMachineShop.com is the world's first online machine shop – putting the power of a **machine** shop in everyone's hands! It lets everyone from consumers to Fortune 1000 product engineers download free, easy-to-use software which they can use to design objects ranging from personal computer chassis and car parts to door knobs in metal, plastic or other materials. As soon as the part is drawn customers receive an instant quote. They may then order the product online. eMachineShop receives orders over the internet for processing.

This places state of the art manufacturing – and the ability to make parts using injection molding, milling, turning, laser cutting, water jet cutting, wired EDM, tapping, bending, blanking, punching, plastic extrusion, thermoforming -- at the user's fingertips.

The online **machine shop** concept is a remarkable new way to unleash revolutionary products. As the first true online alternative to conventional machine shops, eMachineShop allows you to download free software, choose machines, processes, and finishes as the user designs whatever part they need.

Customer orders are quickly machined and delivered - at a competitive price. The online **machine shop** has quickly gained popularity because it saves time that would otherwise be spent by customers traveling between vendors, calling, faxing, emailing and awaiting quotes – the antiquated process to get work done by conventional **machine** shops. As energy prices soar and productivity becomes even more critically important to success, eMachineShop improves the way custom parts are designed and purchased.

Time is important to all of us and at www.eMachineShop.com customers may invent and create new things in ways that substantially shorten the product development cycle. Quantity ranges from 1 to 1,000,000 are accommodated. Add to that eMachineShop's FREE Intelligent design software that gives instant and exact pricing, an artificial intelligence "**machining** expert" offering instant feedback, and the result is unrivaled convenience to the customer.

Parts may be designed and custom machined at the click of a mouse. Now, if you have a computer, you can create custom parts whether it's one part for a racing bicycle or a million parts for a new mass market product. eMachineShop takes the hassle and time out of getting custom parts by providing free downloadable design software. This free software gives you immediate expert design feedback, instantly computes the quotation for parts in any quantity, and follows up with order placement and tracking over the internet.

Government agencies, Fortune 1000 companies, laboratories, universities, small companies, individuals, manufacturers, product designers, mechanics, scientists, inventors, and even conventional shops with overloads, are already customers of eMachineShop.