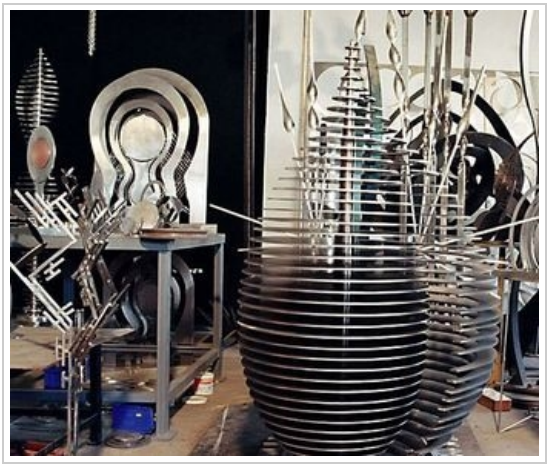
nontoxicprint Health in the Arts

LASER-CUTTING-SAFETY 3D PRINTING

Introduction to Metalworking & Welding Safety



Balan Nambiar, indian artist born in 1937.
This is his studio for stainless steel sculpture
in Bangalore, India in 2005

Metalworking
(From Wikipedia, the free encyclopedia)

Metalworking is the process of working with metals to create individual parts, assemblies, or large-scale structures... It includes a correspondingly wide range of skills, processes, and tools.

Modern metalworking processes, though diverse and specialized, can be categorized as forming, cutting, or joining processes. Today's machine shop includes a number of machine tools capable of creating a precise, useful workpiece.

General metalworking processes

Metalworking generally is divided into the following categories, forming, cutting, and, joining.

Forming processes

These forming processes modify metal or workpiece by deforming the object, that is, without removing any material. Forming is done with a system of mechanical forces (example: bending) and, especially for bulk metal forming, with heat. A red-hot metal workpiece is inserted into a forging press.

Cutting

Cutting is a collection of processes wherein material is brought to a specified geometry by removing excess material using various kinds of tooling to leave a finished part that meets specifications.

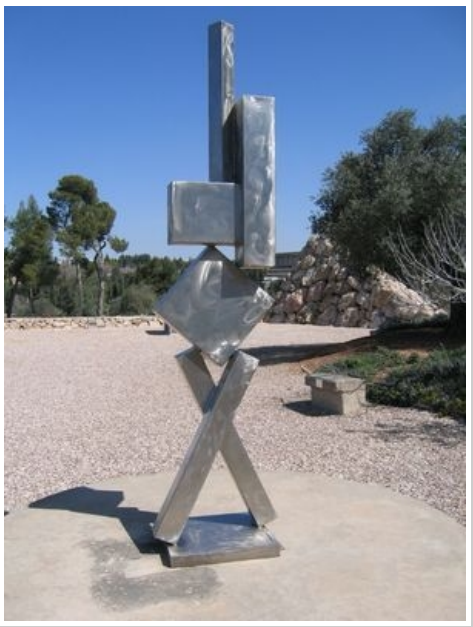
Cutting processes fall into one of three major categories:

- Chip producing processes most commonly known as machining
- Burning, a set of processes wherein the metal is cut by oxidizing a kerf to separate pieces of metal
- Miscellaneous specialty process, not falling easily into either of the above categories

Drilling a hole in a metal part is the most common example of a chip producing process. Using an oxy-fuel cutting torch to separate a plate of steel into smaller pieces is an example of burning. Chemical milling is an example of a specialty process that removes excess material by the use of etching chemicals and masking chemicals.

There are many technologies available to cut metal, including:

- Manual technologies: saw, chisel, shear or snips
- Machine technologies: turning, milling, drilling, grinding, sawing
- Welding/burning technologies: burning by laser, oxy-fuel burning, and plasma
- Erosion technologies: by water jet, electric discharge, or abrasive flow machining.
- Chemical technologies: Photochemical machining



David Smith, CUBI VI, (1963), Israel Museum, Jerusalem. (Wikipedia)

Milling

Milling is the complex shaping of metal or other materials by removing material to form the final shape.

Milling machines may be operated manually or under computer numerical control (CNC), and can perform a vast number of complex operations, such as slot cutting, planing, drilling and threading, rabbeting, routing, etc. Two common types of mills are the horizontal mill and vertical mill.

Turning

Turning is a metal cutting process for producing a cylindrical surface with a single point tool. The workpiece is rotated on a spindle and the cutting tool is fed into it radially, axially or both. ..A lathe is a machine tool which spins a block or cylinder of material so that when abrasive, cutting, or deformation tools are applied to the workpiece, it can be shaped to produce an object which has rotational symmetry about an axis of rotation. Examples of objects that can be produced on a lathe include candlestick holders, table legs, bowls, or baseball bats.

Grinding (abrasive cutting)

Grinding uses an abrasive process to remove material from the workpiece. A grinding machine is a machine tool used for producing very fine finishes, making very light cuts, or high precision forms using an abrasive wheel as the cutting device. This wheel can be made up of various sizes and types of stones, diamonds or inorganic materials.

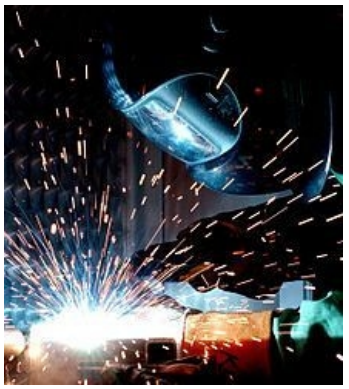
The simplest grinder is a bench grinder or a hand-held angle grinder, for deburring parts or cutting metal with a zip-disc.

Grinders need to be very rigid machines to produce the required finish. Some grinders are even used to produce glass scales for positioning CNC machine axis.

In the past grinders were used for finishing operations only because of limitations of tooling. Modern grinding wheel materials and the use of industrial diamonds or other man-made coatings (cubic boron nitride) on wheel forms have allowed grinders to achieve excellent results in production environments instead of being relegated to the back of the shop.

Filing

A file is an abrasive surface like this one that allows machinists to remove small, imprecise amounts of metal.



welding in progress

Filing is combination of grinding and saw tooth cutting using a file. Prior to the development of modern machining equipment it provided a relatively accurate means for the production of small parts, especially those with flat surfaces. The skilled use of a file allowed a machinist to work to fine tolerances and was the hallmark of the craft. Today filing is rarely used as a production technique in industry, though it remains as a common method of deburring.

Joining processes

- **Mig welding**
- **Welding**

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint, but sometimes pressure is used in conjunction with heat, or by itself, to produce the weld.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding can be done in many different environments, including

open air, underwater and in space.

**Regardless of location, however, welding remains dangerous,
and precautions must be taken to avoid burns,
electric shock, poisonous fumes,
and overexposure to ultraviolet light.**

Brazing

Brazing is a joining process in which a filler metal is melted and drawn into a capillary formed by the assembly of two or more work pieces. The filler metal reacts metallurgically with the workpiece(s) and solidifies in the capillary, forming a strong joint. Unlike welding, the work piece is not melted. Brazing is similar to soldering, but occurs at temperatures in excess of 450 °C (842 °F). Brazing techniques include, flame brazing, resistance brazing, furnace brazing, diffusion brazing, and inductive brazing.

Soldering

Soldering is a joining process that occurs at temperatures below 450 °C (842 °F). It is similar to brazing in the fact that a filler is melted and drawn into a capillary to form a join, although at a lower temperature. Because of this lower temperature and different alloys used as fillers, the metallurgical reaction between filler and work piece is minimal, resulting in a weaker joint.

Riveting

Riveting is one of the most ancient metalwork joining processes. Its use has declined markedly during the second half of the 20th century, but it still retains important uses in industry and construction into the 21st century. The earlier use of rivets is being superseded by improvements in welding and component fabrication techniques.A rivet is essentially a two-headed and unthreaded bolt which holds two other pieces of metal together. Holes are drilled or punched through the two pieces of metal to be joined.

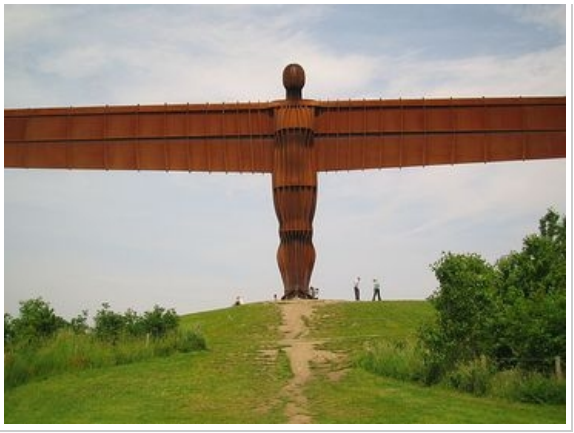
Metals can be heat treated to alter the properties of strength, ductility, toughness, hardness or resistance to corrosion.

Common heat treatment processes include annealing, precipitation strengthening, quenching, and tempering. The annealing process softens the metal by allowing recovery of cold work and grain growth. Quenching can be used to harden alloy steels, or in precipitation hardenable alloys, to trap dissolved solute atoms in solution. ..Often, mechanical and thermal treatments are combined in what is known as thermo-mechanical treatments for better properties and more efficient processing of materials. These processes are common to high alloy special steels, super alloys and titanium alloys.

Plating

Electroplating is a common surface-treatment technique. It involves bonding a thin layer of another metal such as gold, silver, chromium or zinc to the surface of the product. It is used to reduce corrosion as well as to improve the product's aesthetic appearance.Thermal sprayingThermal spraying techniques are another popular finishing option, and often have better high temperature properties than electroplated coatings.

The Angel of the North by Antony Gormley, 1998 (Wikipedia)



Welding and Metalworking: Safety Considerations

Welding -
There are numerous hazards associated with welding, such as burns, eye damage from ultra violet rays and inhalation of toxic fumes generated during the welding process:

Manganese -
From carbon steel or heavy production welding of other steel can cause nerve system damage resulting in Parkinson's Disease.

Nickel -
From nickel alloy electrodes, nickel plating and cryogenic steel, Nickel, like Chromium VI, is a suspect cancer causing agent.

Lead -
Most steels have some lead, higher levels in maraging steel and from lead paint on existing metal surfaces. Lead damages muscles, bone and nerves; especially dangerous to welders' families with children, ages 6 or under.

Copper -
Welding wires (MIG), Bronze, Copper Coating, and Copper Brazing, Brass - Lung irritation.

Zinc -
Zinc plated metal, galvanized metals can cause "Metal Fume Fever" (flu-like symptoms.)

Ozone -
Generated during MIG & TIG welding and aluminum welding. Can cause throat irritation and eye, nose and lung damage.

GENERAL PRECAUTIONS:

If you're welding or cutting surfaces coated with paint, solvents, plastics and other coatings, there is a likelihood of exposure to decomposition products, such as oxides of nitrogen, phosgene, carbon monoxide and carbon dioxide.

It is imperative that proper ventilation be used for all welding processes.
Lastly, compressed gas cylinders can be damaged and explode if not properly protected.

excerpt:

"Depending on the type of art materials used, artists can develop the same types of occupational diseases as industrial workers. Studies have shown that people who work with hazardous art chemicals can develop dermatitis, lead poisoning, silicosis, liver and kidney damage, nerve damage, reproductive problems, carbon monoxide poisoning, cancer and other ailments."

Connecticut College Art Safety Department

https://www.conncoll.edu/offices/environmental-health-and-safety/art-safety/