# ANALYSIS OF MATERIALS

# 7. APPLICATION OF MATERIALS I

## 7.1. Industry Mining

Mining is the extraction of valuable minerals or other geological materials from the earth from an orebody, lode, vein, seam, or reef, which forms the mineralized package of economic interest to the miner. Ores recovered by mining include metals, coal, oil shale, gemstones, limestone, dimension stone, rock salt, potash, gravel, and clay. Mining is required to obtain any material that cannot be grown through agricultural processes, or created artificially in a laboratory or factory. Mining in a wider sense includes extraction of any non-renewable resource such as petroleum, natural gas, or even water.

Mining of stone and metal has been done since pre-historic times. Modern mining processes involve prospecting for ore bodies, analysis of the profit potential of a proposed mine, extraction of the desired materials, and final reclamation of the land after the mine is closed. The nature of mining processes creates a potential negative impact on the environment both during the mining operations and for years after the mine is closed. This impact has led most of the world's nations to adopt regulations designed to moderate the negative effects of mining operations. Safety has long been a concern as well, and modern practices have improved safety in mines significantly. The process of mining from discovery of an ore body through extraction of minerals and finally to returning the land to its natural state consists of several distinct steps. The first is discovery of the ore body, which is carried out through prospecting or exploration to find and then define the extent, location and value of the ore body. This leads to a mathematical resource estimation to estimate the size and grade of the deposit.

### Mining Techniques

Mining techniques can be divided into two common excavation types: surface mining and sub-surface (underground) mining. Today, surface mining is much more common, and produces, for example, 85% of minerals (excluding petroleum and natural gas) in the United States, including 98% of metallic ores. Targets are divided into two general categories of materials: placer deposits, consisting of valuable minerals contained within river gravels, beach sands, and other unconsolidated materials; and lode deposits, where valuable minerals are found in

veins, in layers, or in mineral grains generally distributed throughout a mass of actual rock. Both types of ore deposit, placer or lode, are mined by both surface and underground methods.

Some mining, including much of the rare earth elements and uranium mining, is done by less-common methods, such as in-situ leaching: this technique involves digging neither at the surface nor underground. The extraction of target minerals by this technique requires that they be soluble, e.g., potash, potassium chloride, sodium chloride, sodium sulfate, which dissolve in water. Some minerals, such as copper minerals and uranium oxide, require acid or carbonate solutions to dissolve.

Surface mining is done by removing (stripping) surface vegetation, dirt, and, if necessary, layers of bedrock in order to reach buried ore deposits. Techniques of surface mining include: open-pit mining, which is the recovery of materials from an open pit in the ground, quarrying or gathering building materials from an open-pit mine; strip mining, which consists of stripping surface layers off to reveal ore/seams underneath; and mountaintop removal, commonly associated with coal mining, which involves taking the top of a mountain off to reach ore deposits at depth. Most (but not all) placer deposits, because of their shallowly buried nature, are mined by surface methods. Finally, landfill mining involves sites where landfills are excavated and processed.

Sub-surface mining consists of digging tunnels or shafts into the earth to reach buried ore deposits. Ore, for processing, and waste rock, for disposal, are brought to the surface through the tunnels and shafts. Sub-surface mining can be classified by the type of access shafts used, the extraction method or the technique used to reach the mineral deposit. Drift mining utilizes horizontal access tunnels, slope mining uses diagonally sloping access shafts, and shaft mining utilizes vertical access shafts. Mining in hard and soft rock formations require different techniques. Other methods include shrinkage stope mining, which is mining upward, creating a sloping underground room, long wall mining, which is grinding a long ore surface underground, and room and pillar mining, which is removing ore from rooms while leaving pillars in place to support the roof of the room. Room and pillar mining often leads to retreat mining, in which supporting pillars are removed as miners retreat, allowing the room to cave in, thereby loosening more ore. Additional sub-surface mining methods include hard rock mining, which is mining of hard materials, bore hole mining, drift and fill mining, long hole slope mining, sub level caving, and block caving.

## 7.2. Industry Metalworking

Metalworking is the process of working with metals to create individual parts, assemblies, or large-scale structures. The term covers a wide range of work from large ships and bridges to precise engine parts and delicate jewelry. It therefore includes a correspondingly wide range of skills, processes, and tools. Metalworking is a science, art, hobby, industry and trade. Its historical roots span cultures, civilizations, and millennia. Metalworking has evolved from the discovery of smelting various ores, producing malleable and ductile metal useful for tools and adornments. 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 work piece.

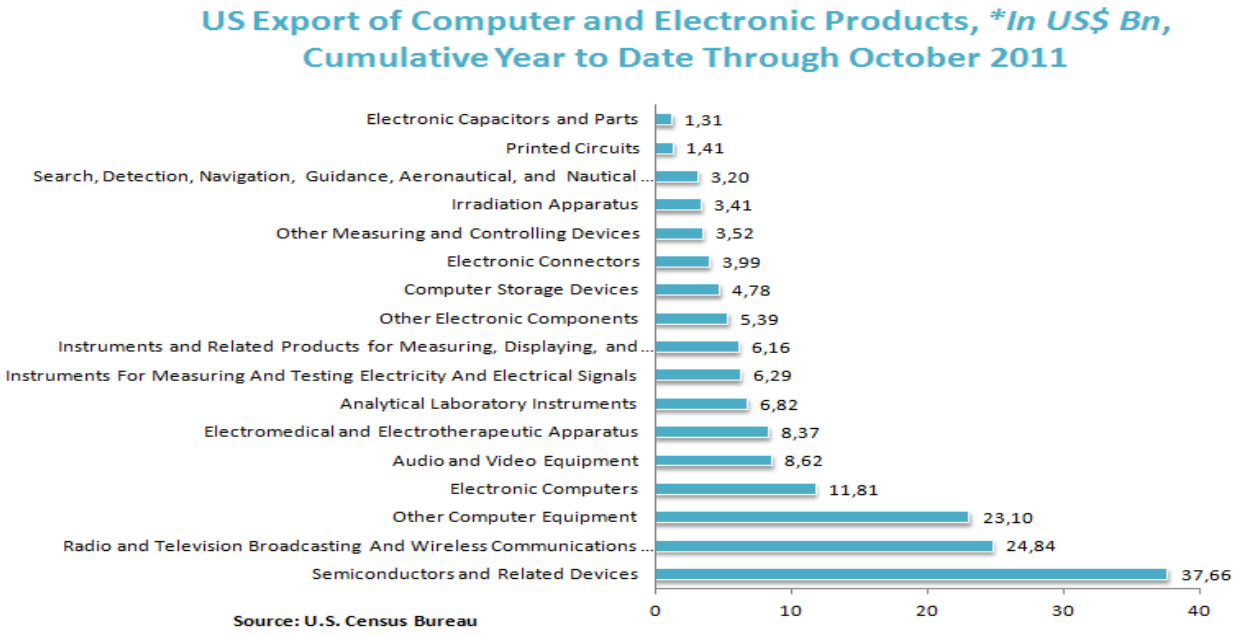
Metalworking generally is divided into the following categories, *forming*, *cutting*, and, *joining*. Each of these categories contain various processes. Prior to most operations, the metal must be marked out and/or measured, depending on the desired finished product. *Marking out* (also known as layout) is the process of transferring a design or pattern to a workpiece and is the first step in the handcraft of metalworking. It is performed in many industries or hobbies, although in the repetition industries the need to mark out every individual piece is eliminated. In the metal trades area, marking out consists of transferring the engineer's plan to the workpiece in preparation for the next step, machining or manufacture. *Calipers* are hand tools designed to precisely measure the distance between two points. Most calipers have two sets of flat, perpendicular edges used for inner or outer diameter. These calipers can be accurate to within one-thousandth of an inch (25.4 μm). Different types of calipers have different mechanisms for displaying the distance measured. Where larger objects need to be measured with less precision, a tape measure is often used.

### History

By the historical periods of the Pharaohs in Egypt, the Vedic Kings in India, the Tribes of Israel, and the Maya civilization in North America, among other ancient populations, precious metals began to have value attached to them. In some cases rules for ownership, distribution, and trade were created, enforced, and agreed upon by the respective peoples. By the above periods metalworkers were very skilled at creating objects of adornment, religious artifacts, and trade instruments of precious metals (non-ferrous), as well as weaponry usually of ferrous metals and/or alloys. These skills were finely honed and well executed. The techniques

were practiced by artisans, blacksmiths, atharvavedic practitioners, alchemists, and other categories of metalworkers around the globe. For example, the ancient technique of granulation is found around the world in numerous ancient cultures before the historic record shows people traveled to far regions to share this process that is still being used by metalsmiths today. As time progressed metal objects became more common, and ever more complex. The need to further acquire and work metals grew in importance. Skills related to extracting metal ores from the earth began to evolve, and metalsmiths became more knowledgeable. Metalsmiths became important members of society. Fates and economies of entire civilizations were greatly affected by the availability of metals and metalsmiths. The metalworker depends on the extraction of precious metals to make jewelry, build more efficient electronics, and for industrial and technological applications from construction to shipping containers to rail, and air transport. Without metals, goods and services would cease to move around the globe on the scale we know today.

## 7.3. Electronic Manufacturing Industry




The global electronics manufacturing industry involves the assembling of electronic goods for domestic, professional, State and military use. Electronics are also used in other industries in the manufacture of a range of goods including appliances, vehicles and toys. Manufacturing companies can be broken down into categories according to what they produce. The main categories of products

include: equipment used in the fields of telecommunications, engineering, laser processing, photography and medicine, machinery components, lighting and consumer electronics.

Manufacturing companies are obliged to deal with other manufacturers as much of the raw materials they use involves intermediate components. Apart from nurturing a strong business relationship, these companies often locate near one another to cut transport and inventory costs and to afford smooth collaboration for research and development. One such example is Silicon Valley in California where a cluster of companies operates in close proximity to manufacture software and computers. The global electronics manufacturing industry is comprised of relatively small companies for the most part. Electronics products are becoming cheaper and being produced faster thanks to the industry's supply chain, which is becoming more and more globalized. Much of the electronic goods manufactured by the industry come from Asia, with China the number one country in terms of production. Outsourcing is common amongst US electronics manufacturers, allowing them to capitalize on profits by cutting production costs. The industry relies on technological innovation, with heavy investment in research and development projects involving highly qualified engineers and technical experts. An increasing degree of automation is making the production of electronics equipment faster and helping to keep the pace of production up with that of constantly evolving designs.

## Key Segments

- The global consumer electronics industry has an estimated worth of close to $7 trillion, according to Business Insights. This highly competitive industry is seeing extensive convergence of market, products and technologies, fuelled by miniaturization, digitalization, and mobility.

- The global electronic manufacturing services industry is expected to grow by almost 9% yearly throughout the five-year period ending in 2015, according to MarketLine, at which point the market would be worth almost $300 billion. Most electronic equipment manufacturers are at the service of original equipment manufacturers.

- Electronics materials and chemicals refer to substances necessary to make printed circuit boards and semiconductors, and exist in liquid, gaseous, and solid forms. According to BCC Research, demand for these substances will enjoy an annual growth rate in excess of 12.5% through 2015.