Scarsdale Middle School Technology Education

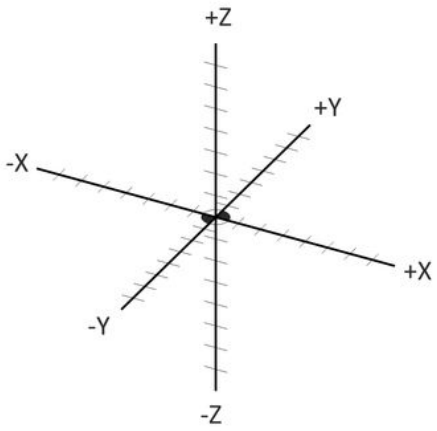
Mr. Rambone Name_____

Technology Education Grade 7
Review Packet #2- 3D Printing, Plastics & Metallurgy

3D Printing

3D printers create a three dimensional object by building it layer by successive layer, until the entire object is complete. It creates objects by adding material on top of itself. It's much like printing in two dimensions on a sheet of paper, but with an added third dimension: the Z-axis.

Each of these printed layers is a thinly-sliced, horizontal cross-section of the eventual object. Imagine a multi-layer cake, with the baker laying down each layer one at a time until the entire cake is formed. 3D printing is somewhat similar, but just a bit more precise than 3D baking. For a 3D printer to work it uses the 3 coordinates X, Y & Z axis.



The X axis (left and right) Y axis (front to back) and the Z axis (up and down)

MakerBot 3D printer

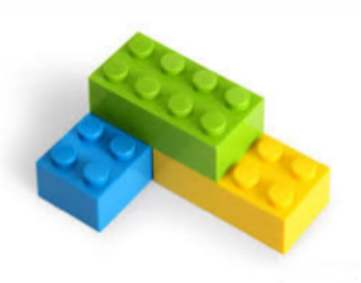
It begins with a digital file

In the 2D world, a sheet of printed paper output from a printer was "designed" on the computer in a program such as Microsoft Word. The file — the Word document — contains the instructions that tell the printer what to do.

In the 3D world, a 3D printer also needs to have instructions for what to print. It needs a file as well. The file — a Computer Aided Design (CAD) file — is created with the use of a 3D modeling programs such as Blender, SketchUp and many others. In this class we will be using the 3D modeling program called TinkerCad. In order for the 3D printer to operate your design must be saved in a STL file (STereoLithography file)

Scale

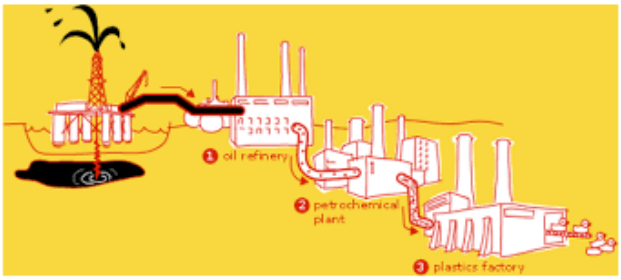
In architecture, it is important to understand scale. Scale means to keep things in proportion to each other. In other words, when designing our village in class we want to make sure all the buildings are proportional in size. For example, we would not want our house we are designing to be 5 times bigger then an office building. In this class, the scale we use when designing our buildings for 3D printing is, for every 1/8 inch it equals 10 feet. So a building that is 50 feet wide would be 5/8" wide in scale.



PLASTICS

• Plastics are all around us. Plastics became popular as a material to make things after World War 2.

• Most plastic is made from oil.



Some newer plastics are bio-plastics which means it is made from vegetable products like potatoes, sugar cane or corn.

The plastic we use in our 3D printers is made from corn.

It is called PLA plastic (Polylactic acid). It is a nontoxic resin derived from field corn and has a semisweet smell (like waffles) when heated.

THE TWO TYPES OF PLASTICS

Thermoplastics

A thermoplastic is a type of plastic, which becomes soft when heated and hard when cooled. Thermoplastic materials can be cooled and heated several times. They can be recycled. When thermoplastics are heated, they melt to a liquid.Thermoplastics are usually soft and bendable. We are using PLA plastic which is a thermoplastic in our 3D printers.

Polyvinyl Chloride (PVC)

PLA
(Polylactic Acid)

Polyethylene

PET
(Polyethylene Terephthalate)

Thermosets

A thermoset is a type of plastic that once an item is made from it can not be melted or softened by heating. They can <u>not</u> be recycled. Thermosets are hard and brittle.

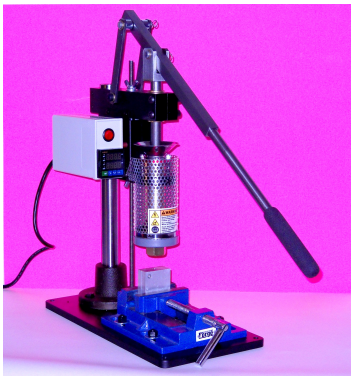
Amino resins

Phenolics

Plastic Injection Molding

Injection Molding- injection molding is a manufacturing process for producing many parts quickly by forcing heated plastic into a mold. Injection molding is used for mass production while a 3D printer is used for making a prototype of one item. In an injection molder, pellets are fed into a heated barrel, melted and forced into a mold by hand pressure or by mechanical means where it cools and hardens.

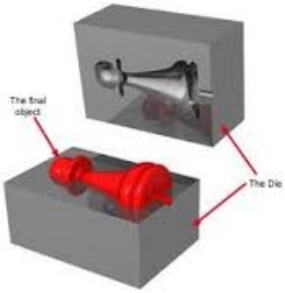
Hand operated injection molder which we use in class



A large Industrial injection molder used in factories (This is the size of a bus)

The mold- In order to make the part needed, a metal mold must be made. The mold is usually designed by an engineer using computer software and then the design is sent to a mold maker who then machines the mold out of metal, usually aluminum.

Sample 2 piece mold for a chess piece



Mold to make plastic spoons used in industrial injection molders.
(Note- this is just the bottom half of the mold)

Generally the material used for injection molding is plastic.

Metallurgy- The science of metals

A metal is a material that is typically hard, shiny, and has good electrical and thermal conductivity. All metals can conduct electricity. That is why wire is made out of metal. Metals can be either elements or alloys (a mix of metals). Metals are generally malleable — that is, they can be hammered or pressed into a shape without breaking or cracking . About 91 of the 118 elements in the periodic table are metals. All metals originate from ore, ore is a rock-like mineral which is mined from the earth.

Classification of Metals

Ferrous metals -Contains iron (The chemical symbol for iron is Fe) - examples, iron and steel (steel is made from iron) Ferrous metals are magnetic and they rust.

Nonferrous metals – Does NOT contain iron. Nonferrous metals do not rust and are not magnetic. Some examples, aluminum, tin ,copper and lead are just a few. The key tag you are making in this class is made out of Nickel Silver which is a non ferrous metal.

MOH's Scale

Mohs Scale- A scale of the hardness of minerals. the softest mineral on Mohs scale is talc, the hardest with a rating of 10 is diamond. The idea of this scale is, something harder can cut or scratch something that is softer. The analogy I like to use is, a knife can cut a birthday cake, but the birthday cake can not cut the knife.

COMPUTER AIDED MACHINING

Computer Aided Machining (**CAM**) is used in industry, especially in the metal working field. It is when a machine tool is hooked up to, and run by a computer. It can be used to cut shapes out of metal or engrave on metal, it is highly accurate and fast. One example would be a milling machine, another would be what we use in this class, the IS 400 engraving machine. We use CAM in this class to engrave on our metal. The program we use to set up our plates is Adobe Illustrator.

Some Common Metals

Metal	Element or Alloy	Chemical symbol	Description & Uses
Aluminum	Element	Al	A light weight inexpensive silvery metal used for aircraft and automotive parts. It is the most abundant metal on the earths surface. It is used for beverage cans, aircraft & automotive parts, pots & pans & baseball bats.
Iron	Element	Fe	Usually dark gray or black. Very heavy and strong, but in its pure form it is brittle. Used for car engine blocks, and alloyed into steel to make other items.
Copper	Element	Cu	A reddish color, the color of a penny. Copper turns green when exposed to air and moisture. One major use is electrical wire and plumbing pipes. The Statue of Liberty is made out of copper.
Lead	Element	Pb	A very heavy, inexpensive soft metal. Gray in color. Used for weights and blocking radioactive waves such as X-rays. Used to be mixed into paints and pottery glazes but outlawed since the mid 1970's in the USA. Can cause brain damage when ingested.
Brass	Alloy	-	An alloy of copper and zinc. Looks like gold. Used for musical instruments, locks, keys, hinges, decorative hardware and boat hardware.
Nickel Silver	Alloy	-	An alloy of nickel, copper, and zinc. Looks like real silver. It used to be called German Silver. The Key tags we are making in class are made of Nickel Silver.
Steel	Alloy	-	A mix of iron and carbon. A very strong and hard metal. Used for car bodies, construction beams, metal cabinets and hardware such as nails, bolts and screws.
Stainless Steel	Alloy	-	An alloy of steel and chromium. Used for kitchen sinks, tableware, pots and pans and boat fittings. It will never rust. The DeLlorian car (Back to the Future car) was made out of stainless steel

The "Precious Metals"

Platinum	Element	Pt	A very expensive metal. Used for jewelry and for expensive electronics.
Gold	Element	Au	An extremely valuable metal, it is yellow in color. Used for jewelry and some coins. A very heavy, yet soft metal. Stays brilliant in color over the years.
Silver	Element	Ag	Used for jewelry, expensive silverware and some coins.

Metal Terminology

ELEMENT- the smallest particle in nature, something which can not be broken down any further. Currently there are 118 elements on the periodic table.

ALLOY- two or more metals mixed together, generally done to make the metal stronger.

BURR- Sharp pieces of metal caused when drilling or filing metal.

BUFFING COMPOUND (Jewelers Rouge)- The red clay like material that is applied to the buffing wheel to polish metal.

TARNISH (ING)- when nonferrous metals darken & turn colors. Does not weaken the metal.

RUST (ING) - a flaking process which can weaken ferrous metals. Remember, only ferrous metals can rust.

MELTING POINT- The temperature in which metal melts. Each metal has its own melting point. For example, iron melts at 2800 degrees while silver melts around 1700 degrees.

JUMP RINGS – Round metal loops which enable you to put a key ring or necklace on an object.

ORE- A rock like material in which all metal comes from.

Metal generally comes in three forms- Sheet metal, bar stock and wire. In our school we buy sheet metal and wire for our projects.

Bonding metal by soldering

Soldering- Soldering is used to bond together non ferrous metals. While welding is used to bond together ferrous metals. There are two types, Soft soldering which is usually a lower heat and uses a soldering iron. The other type is called Silver soldering . Silver soldering uses a blow torch and pieces of silver to form the bond.

To correctly solder using a soldering iron, you must heat up the base metal and apply the solder to the metal (jump ring) and NOT the soldering iron.

A soldering Iron

Solder

Tools for Metalwork

Drill Press

Center Punch

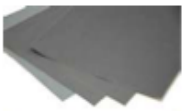
Anvil

Buffing Machine

Rawhide Mallet

Needle nose pliers

Silicon Carbide Sandpaper



Acetylene Torch
(for silver soldering)

Metal File

Diagonal cutters

Soldering Iron
(for soft soldering)