Enclosure Drawings

- The term enclosure is used to describe the housing or packaging within which the electronics is to be located.
- Large manufacturers may have a designated package designer.

Packaging of Electronics

Package Design

- This packaging can be as simple as a simple sheet metal rectangular enclosure that is not weather proof or as complex as a printer housing.

Design Considerations

- Housing Materials
  - Conductive, Heat Resistant or not
  - Weather Tight or not
  - Fastener selection
  - Appearance concerns

Packaging Design Considerations

- Environment, (temperature, humidity etc…) within which product will be used.
- Appearance
- Durability
- Access for repair/ replacement of components
Fasteners

- Fasteners and threaded features must be specified on your engineering drawing.
  - Threaded features: Threads are specified in a thread note.
  - General Fasteners: Purchasing information must be given to allow the fastener to be ordered correctly.

Fasteners

- Fasteners include:
  - bolts and nuts (threaded)
  - set screws (threaded)
  - washers
  - keys
  - pins
- Fasteners are not a permanent means of assembly such as welding or adhesives.

Thread Definitions

- **Internal Thread**: Internal threads are on the inside of a member.
  - An internal thread is cut using a tap.

Thread Definitions

- **External Thread**: An external thread is cut using a die or a lathe.

The five general types of standard threaded fasteners are:

- **Bolt**: A mechanical threaded device with a head on one end and threads on the other end. Bolts are paired with nuts. A nut is a mechanical threaded device used on the end of a bolt, a stud, or a machine screw.
- **Stud**: A rod that is threaded on both ends and joins two mating parts. A nut may be used on one end.
- **Cap screw**: A mechanical threaded device with a head on one end and threads on the other end. Cap screws join two mating parts and have longer threads than bolts. Also, cap screws can be made with slotted heads.
- **Machine screw**: A mechanical threaded device with a head on one end and threads on the other end. The threaded end may screw into a mating part, or may be used with a nut. A machine screw is similar to a cap screw, but it is normally smaller.
- **Set screw**: A mechanical threaded device with or without a head, used to prevent rotation or movement between parts, such as a shaft and a collar. Set screws have different types of points and heads for different applications.

Vocabulary Terms

- **Thread series**: The number of threads per inch for a given diameter.
- **Threads per inch**: The number of threads in one inch, measured axially (parallel to the axis); the reciprocal of the pitch.
Specification of Threads

- Thread form is the shape or profile of a screw thread. Many types of thread forms have been developed.
- The thread series refers to the standard number of threads per inch, and there are four classes: coarse (C), fine (F), extra fine (EF), and constant pitch.

Using Threaded Fasteners

- To specify a thread, you must provide a minimum of five pieces of information:
  - Thread form
  - Thread series
  - Major diameter
  - Class of fit
  - Threads per inch

Specification of Threads

- **Coarse series** fasteners are used for quick assembly or disassembly of cast iron, soft metals, and plastic, and are designated NC or UNC.
- **Fine series** fasteners are used when a great deal of force is necessary for assembly, and are designated NF or UNF. These fasteners are used extensively in the aerospace and automotive industries.
- **Extra fine** series fasteners are used when the length of engagement is short and the application calls for high degrees of stress.

Specifying Threaded Fasteners

Bolts and screws are specified in the following:

- Nominal size (major diameter)
- Threads per inch
- Length
- Name
- Material

Fasteners Specification

- Examples of thread notes for bolts and nuts are as follows:
  - .500–13 UNC X 2 Hex Cap Screw
  - 1/2–13 UNCX 2.5 Square Bolt, Steel, Zinc Plated

Proper Callouts for Bolts and Screws
**Nonthreaded Fasteners**

- Nonthreaded fasteners are mechanical devices generally used to prevent motion between mating parts.
- Dowels, pins, keys, rivets, and retaining rings are examples of such fasteners.
- Washers, another type of nonthreaded fastener, are used to lock fasteners or to provide a smooth surface for a fastener.

**Lock Washers**

- Are used to prevent a fastener from coming loose due to vibration or movement. Helical spring and tooth are the most common types of lock washers. Lock washers are specified by giving the name, inside diameter, strength, and material, as follows:
  - HELICAL SPRING LOCK WASHER—5/16 HEAVY—ALUMINUM—ZINC ALLOY.

**Plain Washers**

- Used with bolts and nuts to improve the assembling surface and increase the strength.
- Plain washers are specified by giving the inside diameter, outside diameter, thickness, and type.

**Fastener Pins**

- Common types of pins are dowel, straight, tapered, groove, and spring. Dowel pins are used to keep parts in position, or to prevent slippage after assembly. Dowel pins are specified by giving the name, nominal pin diameter, material, and protective finish, as follows:
  - HARDENED GROUND MACHINE DOWEL—STANDARD SERIES, 1/4 X 2, STEEL
Rivets

- Rivets are metal pins with a head, and are used to attach assembled parts permanently. Rivets are available in a variety of head styles.
- Rivets are generally used for sheet metal, such as attaching the skin of an aircraft to the frame, or ship parts.

Welded Connections

- The specifications and standards adopted by the American Society for Testing Materials and the American Welding Society have improved the quality and acceptance of welded connections over the last 20 years.

Welded Connections

- Field welds are always designated as such on the drawing by a small flag.
- Common welds include the Fillet weld, J Groove, Plug or shot weld, and the V Groove weld.
- Welding is accomplished by applying heat and/or pressure to permanently join the components.

Arc Welding

- Welding is accomplished by applying heat and/or pressure to permanently join the components.
- Welding processes may be arc, resistance or gas.
- Resistance welding is the only method of the three that does not require a filler material and as a result does not add weight to the finished assembly.

Welded Connections

- Welding is accomplished by applying heat and/or pressure to permanently join the components.
- Processes may be arc, resistance or gas.

Gas Welding

- Gas Welding Process
- http://video.google.com/videosearch?q=Arc+welding&hl=en&emb=0&aq=f#q=Gas+Welding+Process&hl=en&emb=0
**Common Welded Connections**

- Butt Joint
- Bevel Weld
- "V" Weld
- Bevel Weld

**Plastics**
- Plastics are often used for electronic packaging because they are lightweight and can be molded to house very compact circuitry such as MP3 players and cell phones.

**Basic Weld Symbols**

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<th>BASIC WELD SYMBOLS</th>
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**Common Material Choices**

- Plastics (there are a variety of types of plastics used for packaging)
- Aluminum
- Steels
Plastics

- Thermoplastics can be easily formed into intricate shapes using an injection molding process.
- A process by which the melted plastics is injected into molds.

Plastics

- Plastics can be divided into two categories
  - Thermoplastic- Can be heated and formed, melted and reformed
  - Thermosetting- Cannot be reformed or melted after initial forming.

Aluminum

- Aluminum has seven desirable properties that make it a popular choice for packaging of electronics:
  - Weight (lighter than most metals)
  - Formability (can easily be formed and machined)
  - Corrosion Resistance
  - Electrical properties- High conductivity
  - Non Magnetic
  - Heat Disipation –(Transfers heat quickly)

Injection Molding

Sheet Metal

- Sheet metal may be formed and bent to create housings using a precut flat pattern.
- The pattern is cut into flat plate usually in a mass production setting
- The flat pieces are then bent into shapes using a break

Steel

- Its heavy weight makes this product a poor choice for many packaging applications.
- Sheet metal housings are the most common type of steel electronics packaging.
Sheet Metal Terminology

- Bend Allowance (length of material around the bend)
- Bend angle (angle through which steel is bent)
- Bend line, (point of tangency)
- Developed length (length of flat sheet required to create bent/formed part)
- Center line of bend (radial line from the center of bend)

Dimensioning Basics

- Text should be a minimum of .125 inches
- Dimensions should all be on a separate layer specifically designated for layers.

Dimensioning Considerations

- Designer must be mindful of how their choice of dimensions may impact tolerances.
- Dimensioning should be done in a manner that is easiest for the machinist and quality control personnel to measure.

Coordinate Dimensioning

- The use of Coordinate or baseline dimensions eliminates the effect of “accumulation of tolerances”, and is useful to the machinist using a positioning table.
Assignment

- Activity 8.1